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A STANDARD SCALE FOR TELESCOPIC OBSERVATION.

WILLIAM H. PICKERING.

FOR POPULAR ASTRONOMY.

In the January number of POPULAR ASTRONOMY is an article under this title by Mr. Lowell, giving in his usual clear style an excellent *resumé* of the reasons why a standard scale for telescopic observations should be generally adopted. The only criticism to be made on the article it seems to me is his apparent implication, which is of course unintentional, that the scale is a new one. In point of fact it has been in use at the Harvard Observatory for the past twelve years, since it was devised at Arequipa in 1891. Indeed, by its use the site of the Lowell Observatory was selected three years later at Flagstaff. It was also employed in studying the climate of Jamaica. The only objection to its use that I have found during this interval is that it is not directly applicable to planetary and lunar observations. If one is studying the Moon for instance with a large instrument, one needs to have a small telescope also at hand, which can at any moment be pointed on a bright star near the Moon and also at about the same altitude. This takes time, and is sometimes inconvenient. I have in practice, therefore, accustomed myself, with a given glass and power to judge by the appearance of the Moon's terminator what degree of indistinctness and motion corresponds to a given division on the Standard Scale,—so named for this reason.

A brief description of the Standard Scale, together with its application to the measurement of an artificial disk will be found in the Harvard *Annals*, Vol. XXXII pp. 120-122. A first reference to it, in its incomplete form will be found in the *Astr. Nach.* 3079, 1892.

With regard to the size of telescope to be adopted, while a six-inch glass such as is proposed by Mr. Lowell is slightly more sensitive than one of five inches aperture, yet when the astronomer has occasion to travel, as in the case of one selecting the site for an Observatory, the latter is so much more portable that I have found it better to use the latter size. A less aperture than

this is insufficiently sensitive to give valuable results. That is to say, there are many places on the Earth where the seeing would frequently seem to be perfect, if we used only a four-inch aperture. Fewer such places are found with a five-inch, and still fewer with a larger aperture. At Arequipa it was sometimes perfect with an aperture of 12.5 inches, but of course such places are very rare.

To test any place thoroughly really involves a year's stay. Thus the seeing during the shorter dry season in Jamaica which included the summer months was decidedly better than that during the longer dry season, or winter months, although the nights were equally clear, and to the naked eye appeared the same.

HARVARD OBSERVATORY, Cambridge.
January 13, 1903.

ROTATION PERIOD OF JUPITER IN 1869 AND 1878.

G. H. HOUGH.

FOR POPULAR ASTRONOMY.

In POPULAR ASTRONOMY for December 1902 Mr. Denning has very properly called in question the rotation period of Jupiter which I found from observations made on the red spot in 1869-70 by Gledhill and Mayer.

The material was derived from the Astronomical Register 1870 and Journal of Franklin Institute, Vol. 59, also an observation Nov. 30, 1869 communicated by private note from Mr. Gledhill. The time of passage of the spot over the central meridian was ascertained by measurement of the drawings. I deduced a rotation period $9^h\ 55^m\ 25^s.8$ as follows:

Date.	Days.	T.	Obs.-Eph.	Observer.
		h m	m	
1869 Nov. 14	0	11 00	+ 0.0	G
" 26	12	11 02.7	+ 16.9	G
" 30	16	13 45	— 15.2	G
1870 Jan. 5	52	12 58.5	— 23.6	Mayer
" 23	70	8 03.5	— 1.8	G
" 25	72	9 46	+ 2.2	G

Subsequently I discussed the observations published in the Observatory for 1880 which are reprinted in POPULAR ASTRONOMY December 1902.

The rotation period $9^h\ 55^m\ 29^s$ seemed the most probable, but one cannot determine a definite period with certainty.

In the absence of direct observations of the time of passage of the spot over the central meridian a multiplicity of material is of little use in deciding a disputed point. I would not insist, how-

ever, that the period $9^h\ 55^m\ 25^s.8$ is correct, but I think we have very good grounds to believe that the period was shorter previous to 1879.

In 1878 the observations for the time of passage of the red spot over the central meridian were sometimes more than 30 minutes in error. Such observations indicating that the spot was somewhere on the disk. In 1879, however, when the attention of observers was called to the necessity of correct times for the passage of the spot over the central meridian of the disk. we got more reliable observations which served to determine the rotation period with some degree of precision.

Some years ago I reduced all the observations made in 1878 which came to my notice. But with the possible exception of Trouvelot, no other observer seems to have determined the passage of the red spot over the central meridian of the disk by direct observation. In the absence of other data I measured the sketches, but it is obvious that in some cases the time when the drawing was made is erroneously given. I find the earliest drawing showing the red spot was made June 2, 1878 by Lohse of Potsdam. In a number of publications the first observation is credited to Pritchett, July 9, 1878. There seems to be some mistake about the latter observation, as the time given is more than one and one-half hours in error.

The time has been printed $18^h\ 56^m$ or $19^h\ 20^m$ Gr. M. T. Fortunately on the sketch appears the shadow of the Second Satellite which enables us to get an approximate time for the passage of the red spot over the central meridian. I deduced $17^h\ 38^m$ Gr. M. T. which brings the observation in harmony with others.

From the observations of Trouvelot I determined R. $9^h\ 55^m\ 33^s.75$ 203 Rot. A normal place computed from Trouvelot's observations, combined with my first normal in 1879 gave R = $9^h\ 55^m\ 33^s.70$, 871 Rot.

The following table exhibits all the observations compared with an ephemeris. The large residuals in the column (Obs-Eph.) would seem to indicate that very little attention was paid to giving the exact time.

R = $9^h\ 55^m\ 33^s.75$

Date.	Days.	T. h m	Obs.-Eph. m	Obs.
1878 June 2	−37	12 15.4	−14	L
July 9	0	17 38	− 6	P
27	18	13 00	+32	D
30	21	10 00	+ 3	L
Aug. 6	28	10 46	+ 5	N
8	30	13 10	+51	N

Date.	Days.	T.	Obs.-Eph.	Obs.
		h m	m	
1878 Aug. 9	31	7 51	− 12	L
21	43	7 50	− 9	N
Sept. 2	55	8 30	+ 43	N
9	62	8 23	− 8	N
14	67	7 20	− 20	N
19	72	6 34	− 14	L
25	78	11 39.5	− 2.8	T
28	81	8 50	− 22	D
30	83	10 49.5	− 0.4	T
Oct. 2	85	12 29.5	+ 1.3	T
6	89	5 37	− 13	L
8	91	8 10	+ 42	D
25	108	6 30	− 0.7	D
Nov. 11	125	5 30	− 4.4	D
12	126	11 06.5	[− 13.7]	T*
23	137	5 05	− 24	D
24	138	11 22.5	[+ 6.4]	T*
29	143	10 27.5	[+ 2.5]	T*
Dec. 16	160	9 24.5	− 5.7	T
23	167	10 17.5	+ 0.4	T
28	172	9 29.5	+ 3.8	T
1879 Sept. 25	443	17 19.5		H

I think there can be no question that the rotation period was shorter in 1878 than in 1879. In fact without any observations whatever one must infer such to be the case from an examination of the curve showing the change in rotation period.

The redspot, owing to its great size and possible mass should not change its rate of drift suddenly and one would not expect a sharp change of direction in the curve indicating rotation period.

Mr. W. F. Denning in *Monthly Notices*, Vol. 89, No. 10, 1899 has compiled observations of the red spot from 1831 to 1899. The paper is one of great interest in showing the probable drift of the red spot in longitude. For the ancient observations he concludes the maximum rotation period was $9^h\ 56^m$ and for the modern observations he finds a minimum rotation period $9^h\ 55^m\ 33^s.4$ in 1877. I am not convinced that the minimum period is correct, but with the uncertain material it seems impossible at the present time to definitely settle the question.

I think, however, it is probable that the range in rotation

* = End of spot observed.

T = Gr. M. T. spot on central meridian.

L = Lohse. *Publicationen des Astrophysikalischen Observatorium zu Potsdam.* 3 Band No. 9.

P = Pritchett. *Publications Morrison Observatory.* No. 1.

D = Dennett. *Astronomical Register*, May 1879.

N = Niesten. *Annals de L'Observatoire Royal de Bruxelles.* T. 3, 1880.

T = Trouvelot. *Monthly Notices.* May 1881.

period for the red spot may be greater than has been observed during the past 23 years.

The elliptical white spots, which I place at the same level as the red spot have given rotation periods $9^h\ 55^m\ 18^s$ to $9^h\ 55^m\ 44^s$.*

LIQUEFACTION OF GASES AND LOW TEMPERATURES.

[CONTINUED FROM PAGE 87.]

We may now summarize some of the results which have already been attained by low-temperature studies. In the first place, the great majority of chemical interactions are entirely suspended, but an element of such exceptional powers of combination as fluorine is still active at the temperature of liquid air. Whether solid fluorine and liquid hydrogen would interact no one can at present say. Bodies naturally become denser, but even a highly expansive substance like ice does not appear to reach the density of water at the lowest temperature. This is confirmatory of the view that the particles of matter under such conditions are not packed in the closest possible way. The force of cohesion is greatly increased at low temperatures, as is shown by the additional stress required to rupture metallic wires. This fact is of interest in connection with two conflicting theories of matter. Lord Kelvin's view is that the forces that hold together the particles of bodies may be accounted for without assuming any other agency than gravitation or any other law than the Newtonian. An opposite view is that the phenomena of the aggregation of molecules depend upon the molecular vibration as a physical cause. Hence, at the zero of absolute temperature, this vibrating energy being in complete abeyance, the phenomena of cohesion should cease to exist, and matter generally be reduced to an incoherent heat of cosmic dust. The second view receives no support from experiment.

The photographic action of light is diminished at the temperature of liquid air to about 20 per cent of its ordinary efficiency, and at the still lower temperature of liquid hydrogen only about 10 per cent of the original sensitivity remains. At the temperature of liquid air or liquid hydrogen a large range of organic bodies and many inorganic ones acquire under exposure to violet light the property of phosphorescence. Such bodies glow faintly so long as they are kept cold, but become exceedingly brilliant

* POPULAR ASTRONOMY, February 1899.

during the period when the temperature is rising. Even solid air is a phosphorescent body. All the alkaline earth sulphides which phosphoresce brilliantly at the ordinary temperature lose this property when cooled, to be revived on heating; but such bodies in the first instance may be stimulated through the absorption of light at the lowest temperatures. Radio-active bodies, on the other hand, like radium, which are naturally self-luminous, maintain this luminosity unimpaired at the very lowest temperatures, and are still capable of inducing phosphorescence in bodies like the platino-cyanides. Some crystals become for a time self-luminous when cooled in liquid air or hydrogen, owing to the induced electric stimulation causing discharges between the crystal molecules. This phenomenon is very pronounced with nitrate of uranium and some platino-cyanides.

In conjunction with Professor Fleming a long series of experiments was made on the electric and magnetic properties of bodies at low temperatures. The subjects that have been under investigation may be classified as follows: The Thermo-Electric Powers of Pure Metals; the Magnetic Properties of Iron and Steel; Dielectric Constants; the Magnetic and Electric Constants of Liquid Oxygen; Magnetic Susceptibility.

The investigations have shown that electric conductivity in pure metals varies almost inversely as the absolute temperature down to *minus* 2000 degrees, but that this law is greatly affected by the presence of the most minute amount of impurity. Hence the results amount to a proof that electric resistance in pure metals is closely dependent upon the molecular or atomic motion which gives rise to temperature, and that the process by which the energy constituting what is called an electric current is dissipated essentially depends upon non-homogeneity of structure and upon the absolute temperature of the material. It might be inferred that at the zero of absolute temperature resistance would vanish altogether, and all pure metals become perfect conductors of electricity. This conclusion, however, has been rendered very doubtful by subsequent observations made at still lower tempertures, which appear to point to an ultimate finite resistance. Thus the temperature at which copper was assumed to have no resistance was *minus* 223 degrees, but that metal has been cooled to *minus* 253 degrees without getting rid of all resistance. The reduction in resistance of some of the metals at the boiling-point of hydrogen is very remarkable. Thus copper has only 1 per cent, gold and platinum 3 per cent, and silver 4 per cent of the resistance they possessed at zero C., but iron still retains 12 per

cent of its initial resistance. In the case of alloys and impure metals, cold brings about a much smaller decrease in resistivity, and in the case of carbon and insulators like gutta-percha, glass, ebonite, etc., their resistivity steadily increases. The enormous increase in resistance of bismuth when transversely magnetised and cooled was also discovered in the course of these experiments. The study of dielectric constants at low temperatures has resulted in the discovery of some interesting facts. A fundamental deduction from Maxwell's theory is that the square of the refractive index of a body should be the same number as its dielectric constant. So far, however, from this being the case generally, the exceptions are far more numerous than the coincidences. It has been shown in the case of many substances, such as ice and glass, that an increase in the frequency of the alternating electromotive force results in a reduction of the dielectric constant to a value more consistent with Maxwell's law. By experiments upon many substances it is shown that even a moderate increase of frequency brings the large dielectric constant to values quite near to that required by Maxwell's law. It was thus shown that low temperature has the same effect as high frequency in annulling the abnormal dielectric values. The exact measurement of the dielectric constant of liquid oxygen as well as its magnetic permeability, combined with the optical determination of the refractive index, showed that liquid oxygen strictly obeys Maxwell's electro-optic law even at very low electric frequencies. In magnetic work the result of greatest value is the proof that magnetic susceptibility varies inversely as the absolute temperature. This shows that the magnetisation of paramagnetic bodies is an affair of orientation of molecules, and it suggests that at the absolute zero all the feebly paramagnetic bodies will be strongly magnetic. The diamagnetism of bismuth was found to be increased at low temperatures. The magnetic moment of a steel magnet is temporarily increased by cooling in liquid air, but the increase seems to have reached a limit, because on further cooling to the temperature of liquid hydrogen hardly any further change was observed. The study of the thermo-electric relations of the metals at low temperatures resulted in a great extension of the well-known Tait Thermo-Electric Diagram. Tait found that the thermo-electric power of the metals could be expressed by a linear function of the absolute temperature, but at the extreme range of temperature now under consideration this law was found not to hold generally; and further, it appeared that many abrupt electric changes take place, which originate proba-

bly from specific molecular changes occuring in the metal. The thermo-electric neutral points of certain metals, such as lead and gold, which are located about or below the boiling-point of hydrogen, have been found to be a convenient means of defining specific temperatures in this exceptional part of the scale.

The effect of cold upon the life of living organisms is a matter of great intrinsic interest, as well as of wide theoretical importance. Experiment indicates that moderately high temperatures are much more fatal, at least to the lower forms of life, than are exceedingly low ones. Professor McKendrick froze for an hour at a temperature of 182° C. samples of meat, milk, etc., in sealed tubes; when these were opened after being kept at blood heat for few days, their contents were found to be quite putrid. More recently some more elaborate tests were carried out at the Jenner Institute of Preventive Medicine on a series of typical bacteria. These were exposed to the temperature of liquid air for twenty hours, but their vitality was not affected, their functional activities remained unimpaired, and the cultures which they yielded were normal in every respect. The same result was obtained when liquid hydrogen was substituted for air. A similar persistence of life in seeds has been demonstrated even at the lowest temperatures; they were frozen for over a hundred hours in liquid air, at the instance of Messrs. Brown and Escombe, with no other result than to affect their protoplasm with a certain inertness, from which it recovered with warmth. Subsequently commercial samples of barley, pea, vegetable-marrow and mustard seeds were literally steeped for six hours in liquid hydrogen at the Royal Institution, yet when they were sown by Sir W. T. Thiselton-Dyer at Kew in the ordinary way, the proportion in which germination occurred was no less than in the other batches of the same seeds which had suffered no abnormal treatment. Bacteria are minute vegetable cells, the standard of measurement for which is the "mikron." Yet it has been found possible to completely triturate these microscopic cells, when the operation is carried out at the temperature of liquid air, the cells then being frozen into hard, breakable masses. The typhoid organism has been treated in this way, and the cell plasma obtained for the purpose of studying its toxic and immunising properties. It would hardly have been anticipated that liquid air should find such immediate application in biological research. A research by Professor Macfadyen, just concluded, has shown that many varieties of micro-organisms can be exposed to the temperature of liquid air for a period of six months without any ap-

preciable loss of vitality, although at such a temperature the ordinary chemical processes of the cell must cease. At such a temperature the cells cannot be said to be either alive or dead, in the ordinary acceptation of these words. It is a new and hitherto unobtained condition of living matter—a third state. A final instance of the application of the above methods may be given. Certain species of bacteria during the course of their vital processes are capable of emitting light. If, however, the cells be broken up at the temperature of liquid air, and the crushed contents brought to the ordinary temperature, the luminosity function is found to have disappeared. This points to the luminosity not being due to the action of a ferment—a "Luciferase"—but as being essentially bound up with the vital processes of the cells, and dependent for its production on the intact organization of the cell. These attempts to study by frigorific methods the physiology of the cell have already yielded valuable and encouraging results, and it is to be hoped that this line of investigation will continue to be vigorously prosecuted by the Jenner Institute.

And now, to conclude an address which must have sorely taxed your patience, I may remind you that I commenced by referring to the plaint of Elizabethan sicence, that cold was not a natural available product. In the course of a long struggle with nature, man, by the application of intelligent and steady industry, has acquired a control over this agency which enables him to produce it at will, and with almost any degree of intensity, short of a limit defined by the very nature of things. But the success in working what appears, at first sight, to be a quarry of research that would soon suffer exhaustion, has only brought him to the threshold of new labyrinths, the entanglements of which frustrate, with a seemingly invulnerable complexity, the hopes of further progress. In a legitimate sense all genuine scientific workers feel that they are "inheritors of unfulfilled renown." The battlefields of science are the centers of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavor, is enough to satisfy the legitimate ambition of every earnest student of Nature. The real warranty that the march of progress in the future will be as glorious as in the past

lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward.

CONCLUDED.

THE STAR OF BETHLEHEM.

J. MORRISON, M. A., M. D., PH. D.

[CONTINUED FROM PAGE 91.]

The star, as we have seen, was not a natural phenomenon, which could be explained by the laws of physics, but what is commonly called a miraculous apparition designed for a special mission and not visible to the natural eye.

* * * * * * * *

The Star of Bethlehem, as already intimated, was a celestial apparition or angelic messsenger designed to conduct the wise men during their journey and visible to them alone. The apparition was probably an angel, and therefore not in the form of a star, because at this time every celestial object, such as a planet, comet, or meteor, was called a "star." The word comet was not then in general use, and even now we commonly speak of meteors as shooting stars. The French people to this day speak of the Moon as "cet astre," using the very same word as in the original Greek. An eminent French philosopher thus wrote of the Moon:

"Et toi, soeur du Soleil, astre qui dans les cieux
Des mortels éblouis trompais les faibles yeux,
Newton de ta carrière a marqué les limites;
Marche, éclaire les nuits, tes bornes sont prescrites."

The Star of Bethlehem is regarded by most people as a *miracle*, but it is more than doubtful whether there is really any such thing as a miracle. All the so-called miracles recorded in Scriptures are capable of a rational and intelligent explanation, and one, too, which does no violence to the physical laws regulating matter, but which is in strict accord with what is now known of the properties of the luminiferous ether which fills all space, and of the nature of spirit and of man as a spiritual being. Many scientific operators of the present day, such, for instance, as wireless telegraphy, etc., would have been regarded in ancient times as miracles. If the spiritual nature of man, as fully set forth in the Scriptures, were fully and generally recognized, biblical exegesis would be put on a basis which infidelity in all its numerous phases could not assail. The Star of Bethlehem, which appeared

PLATE VII.

CAROLINE HERSCHEL.

ÆTAT 92.

to the Oriental philosophers, will never again appear. The necessity for its reappearance no longer exists. It announced to the world the most momentous event in the history of our race, *viz:* the birth of our Lord who lived, died as to the body and rose again taking with Him His body which He made divine, and ascended into the heaven of heavens in the spiritual world, where, in the language of the Apocalyptic writer, He shines forevermore as, "the bright and Morning Star."

[CONCLUDED.]

CAROLINE HERSCHEL.

ELSIE A. DENT.

FOR POPULAR ASTRONOMY.

Nowhere, perhaps, in the whole realm of science, literature or art is there so striking an instance of the genius which Carlyle has defined as *infinite capacity for taking trouble*, as that portrayed by the life of Caroline Herschel, a long life of devotion to science, side by side with her famous brother the great astronomer William Herschel.

William and Caroline Herschel were the children of Isaac Herschel, a musician and bandmaster in the Regiment of Guards stationed at Hanover, Germany. There was a large family of girls and boys, but from her earliest days Caroline seems to have cherished a passionate admiration for her brother William, who was twelve years of age when she was born in 1750. The Herschel home was a very humble one, the father, though a hard-working teacher of music, and well read, being handicapped by a broken constitution, the result of exposure while on active service with his regiment. The mother was a famous housekeeper, but exceedingly narrow-minded, and with a disposition somewhat embittered by misfortune. Caroline was the youngest but one of the family, and seems to have been a lonely, neglected child, the little Cinderella of the household, making and mending for all from the time she was able to hold a needle and thread, unnoticed, and apparently uncared for, except by her father and brother William. She was given the usual education for a girl of her class and country, that education consisting of a bare knowledge of reading and writing, and a thorough knowledge of spinning, knitting and needlework of all kinds, everything, in short, to make her a good German housewife. The father, who was ambitious for his children, educated his boys to the best of

his ability, and a rather unusual thing at that time, even wanted his little daughter to be somewhat liberally educated. Owing to the opposition of the mother, however, this was impossible, but he occasionally gave her violin lessons, these being enjoyed surreptitiously by father and daughter when such favorable opportunities offered as the absence from home of the mother.

In 1757 William Herschel left Germany for England,—as a matter of fact, deserted from the army. He was a delicate lad of nineteen, and the military life upon which he had entered as a member of the Guards band was too severe for his constitution. He settled at Bath, and within a few years became popular and prosperous as a teacher of music. He also conducted concerts, composed anthems and part-songs and acted as organist in the Octagon Chapel, but all this merely as a means to an end,—the pursuit of an innate thirst for scientific investigation, a desire so ardent that a lack of both time and money was as nothing to him in his resolution to follow a scientific career. With this end in view he required a fine telescope, an instrument so expensive that it was quite beyond his means. Such an obstacle, however, was to a Herschel only an incentive to thought and action. He was full of resource, full of enthusiasm and energy, and with his brain on fire with a wonderful conception, a new principle of constructing telescopes, he worked out his theory by making finer and more powerful instruments than were at that time in existence, one of the results of which was that Herschel the fashionable musician discovered a new planet, Uranus, with a home-made telescope.

To return to Caroline, on their father's death in 1757, William took her with him to England to be his housekeeper and to study music with him. Ten days were passed on the journey from Hanover to London, six days and nights being spent in an open postwagon, and four on a stormy voyage, in which the vessel was all but wrecked. On reaching London, Caroline says, her brother took her to see the shops, but she remembers "only the opticians' shops, for I do not think we stopped at any other." Fancy seeing the sights of London as represented by the opticians' shop windows!

Caroline then became her brother's constant companion, and for ten years managed his house, sang at his concerts, copied music and shielded him generally from all domestic worries. There is nothing to show that she had naturally a fine voice. She says: "I took every opportunity when all were from home

to imitate with a gag between my teeth the solo parts of concertos, shake and all, such as I had heard my brothers play on the violin; in consequence I had gained a considerable execution before I learned to sing." And she did learn to sing and to sing very well, for we are told that she was a favorite singer at the oratorio concerts, interpreting the soprano solos in the Messiah, Judas Maccabeus, etc. During this period, too, she commenced her studies in astronomy, not methodically, but, apparently, because, in a house where not only the drawing room but the very sleeping rooms were turned into work shops for the manufacture of high-class telescopes, she could not help absorbing a certain amount of knowledge from the atmosphere. Then, as several years went by, she was found to be so painstaking, so accurate and so absolutely devoted to her brother's interests, that by what one might call a natural result of those qualities in those surroundings, she became herself an astronomer, though, like her voice, her scientific capabilities were the result of cultivation. "In my brother's absence from home, I was of course left solely to amuse myself with my own thoughts, which were anything but cheerful. I found I was to be trained for an assistant astronomer, and by way of encouragement a telescope adapted for 'sweeping' . . . was given me. I was to 'sweep for comets,' and I see by my journal that I began August 22d, 1782, to write down and describe all remarkable appearances I saw in my sweeps. . . But it was not until the last two months of the same year that I felt the least encouragement to spend the starlight nights on a grass plot covered with dew or hoar-frost, without a human being near enough to be within call. . . At the end of 1783 I had only marked fourteen (nebulæ or star-clusters), when my sweeping was interrupted by being employed to write down my brother's observations with the twenty-foot."

In 1787 she received the appointment of Assistant to her brother, who was then Astronomer Royal, and the salary of £50 which was then settled upon her was surely well earned. To her fell the lot of patient attention, the drudgery of calculation, the arrangement and transcription of rough notes, and the preparation from those notes of her brother's papers to the Royal Society of London. From dusk till dawn she sat at his side when he was at his telescope, writing notes of his observations as they fell from his lips, sometimes till the ink froze, besides running to the clocks, to make a memorandum, to fetch and carry instruments, to measure the ground and many other tedious but important duties, all done dexterously, cheerfully and accurately.

There are few, very few, women who could stand the merely physical work which Caroline so gladly performed for the sake of her deep love for her brother. Many years afterwards she wrote some autobiographical notes for her nephew, Sir John Herschel, not to tell of her own life, but of that of his father, and the difficulties he had had to contend with, and incidentally her own pathetic, unsatisfactory and unsatisfied life is revealed, a life so bounded by the life of her famous brother that it seemed to have almost merged in his; but they show a character strong and womanly and noble, though so immersed in or dominated by his stronger personality that it seemed to have no individual existence of its own apart from his. These notes, together with her diary, are full of interesting details of their life and work together, all told with extreme modesty, but showing her self-sacrificing devotion, not to science directly, but to her brother, and therefore indirectly to his great work. She says: "I ate my meals running, or not at all, and slept only when absolutely necessary. . . But I had the comfort to see that my brother was satisfied with my endeavors to assist him," and this was all the reward she desired.

There are many entries in the diary such as these, showing the tedious nature of some of her duties:

Aug. 9. I calculated 100 nebulæ.
10. Calculated 100 nebulæ.
11. I completed today the catalogue of the first thousand nebulæ.
12. Calculated 200 nebulæ of the second thousand.

Sir William was thus relieved of the drudgery and trivial worries which so frequently try the patience and wear out the heart and courage of a man of genius, who with his mind full of great schemes, is forced, for lack of adequate assistance, to waste his precious time and vitality over the trifles which go so far towards producing perfection.

There is an account of a particularly painful accident to Caroline, which entailed much suffering and many weeks' lameness. She had stumbled while running through deep snow in the dark to execute one of her brother's directions as to a change in the motion of the telescope, and became caught on a great steel hook, which entered her right leg above the knee, tearing her flesh cruelly. Her patient and unselfish comment is, "I had the comfort to know that my brother was no loser through this accident for the remainder of the night of the accident was cloudy, and several nights afterwards afforded only a few short intervals

favorable for sweeping, and for over a fortnight there was no necessity for my exposing myself to the severity of the season," and the season was January.

Respecting her own discoveries of eight comets, between the years 1786 and 1797, she has little to say, though she was the first woman to discover a comet and much praise and encouragement were accorded to her by the scientific world. Her regular duties were so exacting, however, that she could seldom sweep the heavens for her own personal observations, but only as an interlude to them, and several of the comets were found when her brother was away from home, and she was therefore at liberty to sweep as she pleased.

Besides these comets she discovered several nebulæ and star-clusters. In 1798 the Royal Society published two of her works, "A Catalogue of 860 Stars observed by Flamsteed but not included in the General Catalogue," and "A General Index of Reference to every Observation of every Star in the above mentioned Catalogue."

Fanny Burney, in her interesting Diary, gives this pen-picture of Caroline: "She is very little, very gentle, very modest and very ingenuous, and her manners are those of a person unhackneyed and unawed by the world, yet desirous to meet and to return its smiles. She and her brother seem gratified with its favor, at the same time that their own pursuit is all sufficient to them without it."

William Herschel married in 1788, and with many quite natural heart-burnings, Caroline had to resign into the hands of his wife the care of her brother's house. This was a sad and lonely period for the loving and intensely jealous sister, but it is pleasant to know that the gentle sister-in-law eventually won her heart, and that they became the most loving and constant of friends.

So, working side by side, the great genius Herschel and his gentle, plodding, worshiping sister grew old, and when at the age of eighty-four years he died full of honors, she was left a desolate, heart-broken old woman of seventy-two. So dependent upon him was she that his death seemed to paralyze all her energies. She was utterly broken down by overwork and grief, and believing that her own end was very near, a craving came to her to leave England and end her days in old Hanover, the home of her childhood, among her own people. This step, in spite of all protests, she took, and never ceased to regret, for, and this is really the saddest part of the story, it was her fate to live twenty-five

long and dreary years in Hanover, surrounded by people who were quite ignorant of the things in which she was most interested, and quite out of sympathy with her, as, indeed, she was with them. For fifty years she had lived in daily contact with men of the highest rank in science, and while she had been "minding the heavens" and helping to extend the knowledge of the world respecting the great universe, her Hanoverian relatives had been pursuing the narrow lives upon which she had turned her back half a century before. Their habits of life, their thoughts and interests were quite diverse. Moreover, she had generously made over to them her little property, and this tie seemed to make it impossible for her to return to England.

In 1823, she writes to Sir John Herschel, to whom she seems to have transferred the allegiance that had been his father's, "I have not above six hours tolerable ease out of the twenty-four, yet I wish to live a little longer, in order that I might make you a more correct catalogue of the 2,500 nebulæ, which is not yet begun, but hope to be able to make it my next winter's amusement."

In 1825 this, her greatest work, was completed, at the age of seventy-five, making eight manuscript books, the merely manual labor of the writing involved being a wonderful performance for a woman of her years. As a matter of fact, for years after this, in congenial surroundings, she would have been capable of good work. For this great Catalogue the Royal Astronomical Society conferred its gold medal upon her, an honor never before or since conferred upon a woman. This work made possible the completion by Sir John Herschel of his father's work, "The Survey of the Nebulous Heavens." She was honored by various societies, but these distinctions were received with genuine humility, indeed with deprecation. "Saying too much of what I have done," she writes, "is saying too little of my brother, for he did all. A little praise is very comforting, and I feel confident of having deserved it for my patience and perseverance, but none for great abilities or knowledge." Again she says, "I did nothing but what a well trained puppy-dog would have done; that is to say, I did what he commanded me. . . Throughout my long spent life, I have not been used or had any desire of having public honors bestowed upon me; and now I have but one wish, that I may take your good opinion of me to my grave."

In spite of her iron constitution, the last twenty-five years of her life were passed in almost constant suffering and anticipation of death. She endured periods of extreme depression from sheer

loneliness, though, in the intervals of comparative relief from rheumatic lameness, due to her great age and many years of exposure to all weathers, she was fond of company, and an attendant at concerts and card parties, the fashionable amusements of the time, but this only when she was able to walk quite erect and without assistance, and to the end of her life she retained her mental faculties. There is an account of her entertaining visitors, among others the Crown Prince and Princess, on her ninety-seventh birthday, by singing to them a little composition of her brother's. It was a weary waiting for death, though, and when at the marvellous age of ninety-eight, her eyes closed to open no more on this life, all who knew her felt relief that the solitary companionless old soul was at rest.

Miss Agnes Clerke, the author of "The Herschels," says of Caroline, "She was not a woman of genius. Her mind was sound and vigorous, rather than brilliant. She had absolute devotion, endurance, self-forgetfulness; she was quick of eye, accurate, obedient, altogether an ideal assistant." Miss Clerke also says that, although the volume of her work was great, a computational error has never been attributed to her.

One cannot but pity Caroline Herschel, and yet she would have scorned such pity. When we remember that her devotion was not really to science at all, but to an individual, and that her own individuality was almost obliterated by her faithful devotion, when we see how her life was crushed by her brother's death, all courage to face the future having left her, we feel that she was not just to herself, that her brother was not generous in allowing her to efface herself as she did, and we wonder whether he really appreciated the great service she rendered him, to say nothing of the complete surrender of her very self. Perhaps he did, though the Memoir shows a somewhat patronizing affection on his part, rather than an adequate return of her unwearying love. Whether he did or not, she should share his fame, for he owed much of it to her. She worked with him, sympathized with and encouraged him, and was at his service day and night for fifty years, performing the most tedious and difficult offices with a cheerfulness and enthusiasm that, if he did appreciate them, must have been an inspiration to him. For this great devotion, quite apart from her original work, Caroline Herschel's name should be remembered and honored wherever Sir William Herschel's name is honored. Her original work was good, but her greatest work was at the side of her companion, through the long hours of drudgery and loving service which enabled Herschel to give to the world his best, and which gave to England her greatest astronomer.

MARE CRISIUM.

W. W. PAYNE.

The frontispiece to this number is plate XXIX of these fine, large scale photographs made at the Paris Observatory by Loewy and Puiseux. The most important feature in this picture is the large dark plain known as Mare Crisium. When the Moon is at a phase to show the first, or northwest quarter, this well-marked plain is easily visible to the naked eye, because its surrounding walls are high and bright, its general level is lower than Mare Fecunditatis and Mare Tranquilitatis, and its shape is oval, being about 281 miles north and south, and 355 miles east and west, taking Webb as authority.

One of the curious features of this interesting deep sea bottom is the many low ridges that extend in a north and south direction. It would almost be expected that folds in this lower surface would appear near the great walls of this sea, but that they should be found in the central regions and all pointing in the same general direction, at once suggests some surface action wholly independent of that concerned in the building of the surrounding walls. The explanation that will account for these apparently different results in the plain markings of Mare Crisium is yet to be found. Think of the Promontarium Aquarum, in the upper left hand angle, at the end of one of these ridges, rising to a height of 11,000 feet. It is readily seen how steep and high must be this promontory on the side next to the sea. Another mountain southeast of Picard, a prominent crater near the western side, rises to the astonishing height of 15,600 feet. Such a mountain wall around this sea with its many deep and torturous passes on every side, indicate something of the grand scale on which things are made in the lunar world.

It is also worth while to say that this deep sea-bottom or dark plain has been observed long and carefully in order to ascertain if any changes in the surface markings could certainly be detected in regard to color or other physical aspect. Slight knowledge, if any, of real value has come to astronomy from the source. One line of observations has been profitable. Some of the small craters on the western side of this sea have been used as points from which to measure libration in longitude. Most of our readers already know that the Moon turns on its axis once during its revolution around the Earth. Its motion of rotation is exactly uniform, as far as known, but its motion in its path

around the Sun is not uniform. Because of these two facts, an observer from the Earth would not see exactly the same face of the Moon presented to him; sometimes he would see more on the western side than usual, at other times a little more on the eastern side. This is what is meant by libration in longitude.

Now if the astronomer measures from one of these minute craters to the western edge of the Moon at different times of the month and the year he can learn just how much the Moon swings backward and forward in this way, or, as astronomers say, determine the Moon's libration in longitute.

The description of the lunar surface shown in this plate might be extended almost indefinitely, but that is not necessary, because nothing new could be said about it for most of our readers. What has already been said shows what a delightful field is here presented to the eye and mind of the student of astronomy whether he be a tyro or a sage. Either will find enough to occupy well and long the best powers of mind he has at command. If he should wander down the terminator two or three hundred miles to the north and stop awhile at Mount Taurus, he might think he was in the wilds of the Rockies or the Alps; but if he should go as much further to the north until to the superb crater Atlas, he would find there scenery the like of which the eyes of no terrestrial mortal has yet beheld.

Every time we look on these noble pictures of Moon secured by the Paris astronomers we feel ourselves under new obligations to them for the grand work already accomplished.

NOTES ON ANCIENT ECLIPSES.

W. H. S. MONCK.

FOR POPULAR ASTRONOMY.

It is evident that for a full historical discussion of ancient eclipses a familiarity with the early records and the early modes of reckoning time is absolutely essential. This I do not possess, and there are very few persons who do; but I think those who have deduced, for example, the secular acceleration of the Moon's motion from these eclipses or who have used them to fix the dates of historical events are frequently not much better informed than I am myself. On taking up the account of any early eclipse, the first question to be answered is, how much is observation and how much is computation? Part of these computations involve the assumption that the present lunar tables are correct, and of

course an eclipse whose date, etc., depends on such computations cannot be used to test the correctness of these tables. In other cases the computed element consists in turning the early chronology into its modern equivalents, which involves the date of the era of Nabonassar,; that of the first Olympiad, etc.; and where these dates are themselves fixed by means of eclipses (as Mr. Wheat seems to do with the Olympiads) there is a double process of computation involving additional uncertainty.

The Rev. S. J. Johnson in his interesting little book on eclipses cites from Ferguson two which are relied on as proving the secular acceleration of the Moon's motion. The first is that of December 23d B. C. 383. It is quoted by Ptolemy from Hipparchus whose work has been lost but who lived long after the alleged date of this eclipse. Hipparchus, it would seem, took it from the Babylonish annals in which of course, the statement that it occurred in the month of Possideon when Phanostrates was governor at Athens was not to be found. This is the rendering of the Babylonish original into Greek time by either Hipparchus or Ptolemy; and it does not seem clear that even Hipparchus had seen the original annals which were presumably kept at Babylon. Failing this, our information seems to be reduced to the allegation that a small eclipse of the Moon was seen at Babylon in the 366th year of Nabonassar; and even the smallness of the eclipse and the morning hour at which it appeared may have been the result of a computation by Ptolemy or Hipparchus instead of a part of the original record. The proof which this eclipse affords of the acceleration of the Moon's motion is that, "according to most of our tables," the Moon had set at Babylon about half an hour before the eclipse began and the eclipse could not therefore have been observed at Babylon if these tables were correct. The Moon must have set later or else the eclipse must have occurred earlier than "most of our tables" imply. But Mr. Johnson seems to regard the lunar table in *The Encyclopedia* as consistent with Ptolemy's description accepting the above date as correct; whence it would seem that the proof of the Moon's acceleration from this eclipse fails in any event.

The other early eclipse relied on by Ferguson to prove this acceleration is also recorded by Ptolemy and is supposed to have been observed at Alexandria on Sept. 22 B. C. 201, when the Moon is said to have risen so much eclipsed that the eclipse must have commenced half an hour before, whereas according to the tables it did not commence till about ten minutes after the Moon had risen. Consequently either the Moon rose later or the eclipse

commenced earlier thah our present tables indicate. The date of this eclipse is, however, prior to the birth of Hipparchus who, moreover, was not an Alexandrian and was a man of mature age when he went to reside at that city; so the question arises as to what Alexandrian records he had access and how far all particulars of this eclipse were recorded in them. Mr. Johnson, however, again objects that according to the table in *The Encyclopedia* the Moon rose considerably eclipsed at Alexandria on the day in question. Possibly the tables in *The Encyclopedia* are based on the assumption of an acceleration in the Moon's motion at the rate of ten seconds per century, in which case Ferguson's results may be correct. But is the date of either eclipse ascertained with sufficient accuracy to enable us to use it for the purpose of checking the correctness of our lunar tables? Is it certain, for instance, that the era of Nabonassar can be ascertained (without any aid from eclipses) without a possible error of ten years? We shall see hereafter that the eclipse of March 19 B. C. 721 has been identified with one which Ptolemy records for the 27th year of Nabonassar. But Mr. Wheat in computing the interval from the Ninevite eclipse of B. C. 763 to a subsequent eclipse makes it 37 years from the date of this eclipse to the accession of Nabonassar. How then could the 27th year of Nabonassar coincide with B. C. 721?

I have not seen the translation of a Ninevite inscription in the British Museum which was deciphered in the year 1867 and is said to be a record of an eclipse which took place on the 15th of June B. C. 763. "My computation," writes Mr. Johnson, "makes it to have been almost total at Nineveh about $9^h\ 47^m$ A. M.," whence I infer that the inscription does not indicate the hour of the day. It took place in the reign of the Assyrian King, Assur-dayan, whom Mr. Wheat makes Assur-danan-il. (The reading of the inscription by different authorities is, I presume, not quite identical.) Assur-dayan will strike many readers as another version of the Biblical Esar-Haddon who ruled in Nineveh about a century after the alleged date of this eclipse. Whether any use of this eclipse has been made in determining the acceleration of the Moon's motion I do not know. If not I presume the *data* are admittedly not sufficiently definite for the purpose.

Mr. Johnson after mentioning this eclipse says that previous to the deciphering of the inscription the most ancient eclipses were three of the Moon to be found in Ptolemy's *Almagest* all of which were observed at Babylon; and he notes that these three are of value for the purpose of ascertaining the Moon's accelera-

tion. "The first of these occurred in the first year of Mardoch-Empadius, the 27th of the era of Nabonassar, in the Egyptian month Thoth, 721 B. C." Now it is certain that Hipparchus did not find the Egyptian month Thoth in the Babylonian record. He is turning Babylonian into Egyptian chronology; and if the Babylonian chronology had been altered after the fall of Babylon, or if Hipparchus writing at a distance was unfamiliar with it, a mistake might easily occur. I do not know when the years of the era of Nabonassar began and ended, but if the beginning and end of the Babylonish year were nearly coincident with ours there is a further difficulty. If B. C. 721 coincided with the 27th of Nabonassar B. C. 382 would coincide with the 366th year whereas the eclipse in the 366th of Nabonassar is set down to B. C. 383. This difficulty would be obviated if the Babylonian year commenced at a different date from ours. But a further difficulty is suggested by Mr. Wheat's remarks. The Babylonian year consisted of 365 days without any leap years. But I apprehend (for I am not certain) that the dates given by such writers as Mr. Johnson, Mr. Wheat, etc., for eclipses before the Christian era are in Julian years. (The cycle of 521 years which I mentioned in your columns some time ago is one of 521 *Julian* years). If the Babylonian years and the Olympiads were computed at 365 days to the year, the difference between the two dates for early eclipses would soon become considerable. In the 202d Olympiad the difference would be over half a year. The proof of the acceleration of the Moon's motion according to Mr. Johnson appears to be that according to the tables in the *Encyclopedia* it began at $7^h\ 7^m$ and ended at $10^h\ 54^m$—he does not say whether in the morning or the afternoon. But Ptolemy apparently only describes it as having occurred in the afternoon. This is in agreement with the tables if they give 7^h to 11^h in the afternoon as the time of the eclipse at Babylon. Whereas if the tables describe the eclipse as occurring in the morning the change is in the wrong direction and implies retardation of the Moon's motion. The other two eclipses of the Moon referred to by Mr. Johnson occurred in the following year, viz.: B. C. 720 if the former is rightly referred to B. C. 721. How they bear on the question of acceleration is not stated; and I may add that from the well-known recurrence of lunar eclipses in cycles (to which I shall again refer) a sequence of three eclipses may be referred to erroneous dates almost as readily as a single eclipse.

The process of computing back and computing forward is practically the same. Now suppose we had a record that Thales had

predicted that there would be a large eclipse of the Sun in China on a particular day, would it be deemed a sufficient verification of this prediction to find in the Chinese annals that there was a great eclipse of the Sun at some date not exactly defined but which could not have been more than ten years earlier or later than that predicted by Thales? But as regards our lunar tables in how many instances are we in even as good a position as this as regards ancient eclipses? (We certainly are *not* as regards the particular eclipse which Thales predicted. And it is quite possible that Thales having ascertained the cause of solar eclipses, merely predicted that they *would* recur without stating when).

I do not of course blame Ptolemy or Hipparchus. They had to give dates intelligible to their readers and no doubt did their utmost to render these dates correct. And probably Hipparchus never dreamt that his dates (reported at second-hand by Ptolemy) would long survive the Babylonian annals whose import he was putting into the form most intelligible to the Greek-speaking Egyptians. But the Babylonian annals have been lost and no accurate transcript of them has come down to us. I do not know whether Ptolemy states that in any instance the eclipses which he cites from Hipparchus were observed by Hipparchus himself. Of those cited by Mr. Johnson only one (in B. C. 141) seems likely to have been so observed and I do not know whether Ptolemy's description is sufficient to fix the date of it precisely. Some others in the *Almagest* may have been observed by Ptolemy, but we want here the same information I write in the hope that some of those who are familiar with these early records will tell us in how many instances the date of an eclipse which occurred more than (say) 1500 years ago can be fixed *independently of our present lunar tables* so as to form a real check upon the accuracy (or inaccuracy) of these tables, and enable us to ascertain whether the Moon's motion has been really accelerated or retarded since the earliest eclipse whose exact date and place can be fixed without any computation based on lunar tables or lunar cycles.

I noticed that in some cases the eclipse must have commenced earlier *or the Moon have set later* than the present tables indicate. If the eclipse took place earlier there would be a longer interval from eclipse to eclipse indicating that the Moon had been revolving round us more slowly in the past than in the present. But if the Moon set later than the tables imply the contrary inference might be made, for the interval between the setting of the Moon on the 23rd of December B. C. 383 and its

setting on the night that I write these lines would be less than that given by the tables for the same number of lunar days. Perhaps it may be said that if the Moon had set later on the 23rd of December B. C. 383 it would not have been eclipsed at setting. I leave that question to the mathematical readers of POPULAR ASTRONOMY. If the later setting of the Moon would not prevent the eclipse it seems as feasible an explanation as the earlier occurrence of the eclipse. Again an eclipse depends on the mutual positions of the Sun, the Earth and the Moon. If a change in the interval between eclipses were proved, the question whether we should seek for the cause in the motions of the Earth or of the Moon (or of both) would remain to be decided.

I already made some comments on the conclusions of the Rev. Mr. Wheat in the columns of POPULAR ASTRONOMY but I may add that I am unable to follow him as regards the eclipse of Phlegon to which he assigns the date of Nov. 24 A. D. 29, while Mr. Johnson assigns Nov. 14 of the same year. Christ celebrated the Passover with His apostles on the night before the crucifixion which latter event seems thus fixed for the 15th of the month Abib. But Mr. Wheat says the Jewish year consisted of 365 days (without any bissextile years) and therefore the 14th or 15th of the month Abib would in the course of time occur at every possible season of the year. True; but as he himself shows the correction for the interval between the Exodus and the crucifixion would be almost exactly one whole year and therefore the 14th day of the month Abib would on both occasions occur at at the same season of our year. How then could the Exodus have taken place in April and the crucifixion in November? The latter event must have occurred some hundreds of years earlier or later in order to bring about this result. For my own part I am not satisfied that either of the darknesses referred to by Mr. Wheat were solar eclipses the former having lasted for three days. Mr. Wheat infers from the eclipse of Phlegon that the Olympiads began in B. C. 780. Mr. Johnson says they began in B. C. 776. A doubt of this kind (until solved) renders records in which the date is given in Olympiads of no scientific value. Taking an Olympiad at four years (of 365 days) the second year of the 202d Olympiad would, however, be the 806th year from the commencement of the era, which computed backwards from Nov. A. D. 29 leads us to B. C. 776 or 777, according to the time of the year when the Olympiad reckoning commenced.

I mentioned in a previous article that the cycle of 521 years which I proposed might admit of sub-division. In point of fact

65 years seems to be a common period for the return of an eclipse especially a lunar eclipse but it is a little later on each return and after four repetitions or 260 years, a period of 261 years (when the eclipse will usually be 11 days earlier than at the end of the second term of 260 years) is necessary to redress the balance and restore the original date in Julian years. Looking at the list of future eclipses in Mr. Johnson's book I find lunar eclipses for 12th of April, 1903 and 13th of April 1968; 15th of Aug. 1905 and 17th of Aug. 1970; 9th of Feb. 1906 and 10th of Feb. 1971; 7th of Dec. 1908 and 10th of Dec. 1973; 3rd of June 1909 and 4th of June 1974, etc. The first of these turns up again on the 14th of April 2033, the second on the 19th of August 2035, the third on the 11th of February 2036 and the fifth on the 6th of June 2039. there being in each instance two successive returns at the end of 65 years, the eclipse becoming a little later on each occasion. But some of those which drop out of the 65 years period seem to recur again at the end of the period of 521 years which is thus more accurate than any of the shorter periods. I may, however, mention another period of 270 years which often separates a lunar eclipse from a solar eclipse. Thus the lunar eclipse of the 12th of April 1903 will be followed by a solar eclipse the 12th of April 2173; the lunar eclipse of the 15th of August 1905, by a solar eclipse of the 16th of August 2175; the lunar eclipse of the 1st of April 1912 by a solar eclipse of the 3d of April 2182; the lunar eclipse of the 4th of July 1917 by a solar eclipse of the 6th of July 2187, and the lunar eclipse of the 7th of November 1919, by a solar eclipse of the 8th of November 2189. The period can also be traced in the opposite direction. A great solar eclipse on the 23d of June 1191 was followed by a total lunar eclipse of June 22, 1461. There seems, moreover, to be several instances in which two or three returns of an eclipse in 521 years is followed by a return in 260 years. I may note that the last return of the lunar eclipse of March 19, B. C. 721, already discussed, took place on March 30, 1885 (N. S. accounting for the change of date.)

I may take this opportunity of correcting an error in my article in the May number of POPULAR ASTRONOMY for 1902. The predicted eclipse of June 17, 1981 will be one of the Moon, not of the Sun, and does not therefore belong to the series of solar eclipses commencing (as recorded) with that of B. C. 104. It is in fact the successor of a lunar eclipse of July 3, 1460 mentioned by Mr. Johnson, the difference in date arising from the Gregorian correction of the calendar. With regard to the eclipse of A. D. 1654 I

think Mr. Johnson's date of August 12 is a misprint for August 2 (and Mr. Wheat is probably correct in assigning the eclipse of Phlegon to the 24th not the 14th of November A. D. 29). My cycles also induce me to set down the future eclipse of A. D. 2433 to the 19th instead of the 10th of April as given by Mr. Johnson. But the question as to certainty of the dates of early eclipses evidently involves the accuracy of all cycles and it is to the importance of ascertaining as many dates as possible on independent grounds and testing our lunar tables by these alone that I specially desire to call attention.

One more remark I may make with regard to Mr. Wheat. The day after the crucifixion appears to have been the Sabbath, so that the crucifixion took place on a Friday. But I am right the 24th of Nov. A. D. 29 was Sunday. The narative, moreover, rather suggests an earthquake or volcanic outburst than an eclipse of the Sun.

REPORT ON THE DELIBERATIONS AND PREPARATIONS FOR THE PUBLICATION OF A NEW CATALOGUE OF VARIABLE STARS.*

[Prepared by G. Müller in the name of the committee appointed by the Board of Directors of the *Astronomische Gesellschaft*, and read at the August 1902 meeting of the *Gesellschaft*.]

Since the appearance of Chandler's last Catalogue in 1896 the number of known variable stars has increased in an unusual degree. To something like 400 objects which are included in the third catalogue of Chandler more than 200 new variables have been added in the last six years, aside from the numerous stars which are suspected of variability and hence merit further watching and attention. The observations undertaken at the Cape Observatory and at Cordova, as well as the investigations at the Harvard Observatory, have furnished the principal contributions to this work and photography has had the largest share in it. The great increase in the number of variables has made it very desirable to have a new catalogue of this class of stars. At the time of the Heidelberg meeting the attention of the directors was called to this need, and the question was brought up whether the society itself (*A. G.*) should not take in hand the preparation of such a catalogue. They arrived at no positive conclusion at Heidelberg, since it did not seem advisable to begin work upon such

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an undertaking without a previous understanding with Mr. Chandler, who has won for himself a prerogative in this department by his three excellent catalogues. After Mr. Chandler had explained in the *Astronomical Journal*, that it was no longer possible for him to carry on the supervision and cataloguing of the variable stars, but that he was ready to support any other undertaking planned in this direction, the directors again took up the question and soon came to the conclusion that the publication of a new catalogue of variable stars would be a fitting task for the *Astronomische Gesellschaft*. The carrying out of this work was given over to a committee for which besides three representatives of the Board of Directors (Dunér, Müller, Oudemans) Herr Hartwig was also chosen. The decision of the Directors scarcely needed any other grounds. Ever since the *Astronomische Gesellschaft* has existed, it has taken an interest in the variable stars. Men like Argelander, Schönfeld and Winnecke have devoted years of hard work to this department of astronomy, and the Society continually manifests its interest in the variables by the regular publication of Ephemerides. Now that the great zone undertaking is gradually drawing to a close and that within a comparatively short time the talents and the means of the Society will no longer need to be devoted to this work alone, the Society is justified in looking about for new tasks.

The publishing of a new catalogue of variables, which probably will make no very heavy demands on the finances of the Society, may be looked upon as a modest beginning in this direction; and the Directors may well allow themselves to hope that this undertaking will meet with the sympathy and support of the society.

The following report is given on the results of the consultations hitherto and the present condition of the project. The committee appointed by the Directors began its work in the past year; the members of the committee have been agreed from the first, that it is not a question of simply completing and enlarging the Chandler Catalogues, but that their task is to produce a perfectly independent catalogue as reliable and as complete as possible, which shall give for the beginning of this century a true picture of the state of our knowledge of the variable stars.

Excellent and thorough as the last Chandler Catalogue is, and however well it may serve as a model in many respects, yet in various points it needs correcting; and so the committee has decided upon a complete revision of the elements of the light-changes in all variables, not only by the addition of new observations but eventually by the working over of old material. A

simple acceptation of the Chandler elements without careful examination is declared unallowable. It will appear in the revision that the variability of some stars in the last Chandler catalogue does not appear sufficiently warranted. The complete removal of such objects from the catalogue might not seem advisable, since it may always happen that there are irregularities in the light-changes. On the other hand it is well to mention doubtful objects as such. Consequently the committee intends to consider these stars in a separate part of the new catalogue together with those new variables which are not yet certainly verified at the time of its publication. Observers will then find in the first part (I) of the catalogue only positively determined variables; in the second part (II) all doubtful objects and those that are awaiting further confirmation.

A third part (III) will be devoted especially to variables in star-clusters. Since in some clusters, as in ω Centauri, many more than 100 stars are known to be variable, one might be debarred from mentioning by special name in the catalogue each one of these variables, which evidently stand in connection to each other. It will rather be deemed better to consider by itself in Part III every cluster to be noticed, and to designate the separate variables of the same by continuous numbers. The statement of position is not in this case sufficient for identification; an exact triangulation of the cluster itself is needed and if possible a detailed map.

A fourth (IV) and last part is intended for the so-called new stars, which cannot in any proper sense be reckoned with the variables and consequently are better treated by themselves. Finally, it is also proposed to add to the catalogue some important tables which will be welcome to the observers and computers of variable stars; in the first place a table of the Julian days and tables for the Algol stars for the reduction from geocentric to heliocentric place.

As the first and most important preparation for the catalogue as planned, the committee has taken pains to collect all the new variables discovered since the appearance of the last Chandler catalogue, and to ascertain from these whether the material at hand is sufficient to determine with some degree of certainty the manner of light-change. At the same time with the responsibility for the new catalogue the committee has undertaken also the surveillance and the naming of the new variables. It is understood, of course, that the method of naming introduced in the *Astronomische Gesellschaft* and adopted by Chandler, will still be

followed; *i. e.*, with the capital letters of the alphabet from R on and with the combination of the same. It is to be hoped that the naming published by the committee will be accepted everywhere so that no confusion of notation may arise.

With regard to the acceptance of a newly discovered variable in the list of those to be regarded as certain, the committee has decided in general to retain the principle of Chandler, only to regard such stars as warranted for which the manner of the light-change has been ascertained by at least two independent observers. The strict carrying out of this principle might lead to the disadvantage that a perfectly recognized variable might be shut out for a long time from the list, only because no second observer of the same chanced to be found. Consequently it will be allowed to depart from this principle in all cases where the details of observation published in full by only one trustworthy observer leaves no room for doubt as to the manner of the light-change. The determination of the variability would in many cases be made essentially easier if the discoverer would publish his estimates in full detail, so that a positive judgment would be possible.

In the new discoveries of the past year photography has played a most important role. Respecting the acceptance of variables discovered by photography the same principles hold good as for the optical variables, *i. e.*, the confirmation by means of a second measurement or by a direct observation must be waited for, with the exception of such cases where the material published in detail furnishes perfect evidence of the variability.

In consideration of the somewhat greater uncertainty of the photographic determination of brightness the committee considers as desirable this condition for the acceptance into the list of known variables: the proof of a photographic variation of brightness of at least a whole magnitude, while in direct observations, about the amplitude of a half magnitude will be considered sufficient. Stars whose observed variation of light amounts to less than a half magnitude can find a place in the catalogue only in a very few exceptional cases.

According to the principles just explained the committee has collected a list of 194 new variables and published them last December in the *Astronomische Nachrichten* and in the *Astronomical Journal*. A second list of 24 stars whose variability has in the mean time been sufficiently proved will soon be made known; and further lists should follow at suitable intervals of time. The flood of discoveries seems for the present to have abated some-

what and as nearly as one can now predict, the new catalogue will contain altogether from 600 to 650 variables.

The committee has planned a radical change in regard to the remarks subjoined to the catalogue. In the Chandler catalogue the remarks were limited to short notes on the discovery, the neighboring stars used in the search and particular unusual peculiarities. Chandler himself regretted the too great limitation to which he was forced for lack of space. The committee is of the opinion that it will not need to limit itself in this respect; so it will follow the example of Schönfeld and will elaborate the notes with especial care and detail.

For the observer this part of the catalogue is at least as important as the list of the elements themselves; and we think we are sure of general approval if we give in the remarks on each variable not only a brief history of the same, but a collection of everything that has been learned concerning the manner of the light-change, the form of the light-curve and any irregularities and peculiarities. The committee has even taken a long step in advance and will make the effort to give in the notes on each variable a bibliography as complete as possible of the most important series of observations and investigations. It is plain that the value of the catalogue would be greatly increased, if the observers could find a statement of all the material at hand and could at once see where there are gaps and where new observations are desirable. The consideration that this part of the catalogue might on account of these references eventually reach a very considerable bulk, seems to the committee unimportant in comparison with the great advantages that may be expected from the new plan.

Much more serious is the effect of this decision of the committee in that the execution of the plan will require a very appreciable outlay of time and work. The literature concerning variable stars has already increased so much that the work of collecting and examining it is very wearisome and takes much time. So it is not to be expected that the catalogue can be completed in a short time. The committee wishes from the start to have no misconceptions on that head. It does not conceal from itself that for the complete carrying out of its program some years of vigorous work will be necessary, but it is of the opinion that, if it succeeds in reaching the goal set, the pains taken will be richly rewarded.

It is not yet time to go into further particulars with regard to the special arrangement of the catalogue as planned. The dis-

cussions within the committee on many particulars have not yet come to an end. But it may be of interest to know how the question of publication has been decided. Considering the extent of the proposed program it was clear from the first that a single worker would not be enough for the undertaking, at least if they wished to avoid great delay in its completion. On the other hand it did not seem advisable for the sake of the uniformity of the work, to engage a large number of workers.

On the proposition of the writer of this report, Herr Hartwig declared himself ready to undertake in company with him the publication of the catalogue. The other members of the committee accepted this offer and promised their coöperation in case further help should be necessary. The two publishers have already arranged the division of the work and they began their activity at the opening of this year. The first thing to be done is the collecting of the literature and the compilation of the catalogue of notes.

The second part of the work will then include the arrangement of the material, the revision and correction of the elements and the preparation of it all for the press.

It is very gratifying that the work planned by us is arousing lively interest in different quarters. Messrs. Chandler and Pickering have voluntarily offered us their support. The industrious observers of the southern heavens, Mr. Inness and Mr. Roberts, have placed their observations at the disposal of the committee. Also Mr. Baxendell in Southport, England, has sent us for use at our discretion very extended observations from the years 1859 to 1886. These series of observations made by his late father and his uncle Pogson, two well-deserving men in the work of variables, have never yet been published. Such assistance is of course most welcome to the committee and will always be received with warm thanks.

Finally, the committee makes this request of the astronomers gathered here: that they, for their part, will also help on the undertaking by sending in series of observations that may not have been published, or also by other contributions. For the younger astronomers especially it would be an instructive task and one well worth the while, to undertake the revision of one or another variable; the committee would be glad to place at their disposal the references to literature and the necessary directions.

As to the cost of the undertaking, except the printing which will probably follow in the quarterly publication of the society, it will be a question of only a comparatively modest sum of

money which the committee asks for to pay its helpers. The extensive program which is proposed for the new catalogue especially the collection and critical examination of the literature, takes so much time that the two publishers could scarcely accomplish the task in any conceivable time without assistance, especially as they cannot devote all their time to this pursuit on account of their other business. Hence it would surely be admitted that some helpers should be placed at their disposal, who could undertake a part of the purely mechanical work in the collection and arrangement of the literature, and if necessary aid in the computations. Consequently the committee has made a request of the Directors for the sum of 2,000 marks, which shalll be given over to it for free use for the purpose mentioned. There can be no need of further explanation of this request. If the society is satisfied that the undertaking planned is a useful one and worthy of the aims of the Astronomical Society then it will be ready gladly to support the same with its means. The work would be essentially lightened in this manner, and we then could hope that by the time of the next meeting an early date for the completion of the work might be in prospect.

[At the close of the reading of the report the society appropriated the sum of 1,000 marks to aid in the preparation of the Catalogue of Variable Stars.—Ed.]

EXPEDITION FOR THE ASCERTAINING OF THE LOCATION OF OBSERVATORIES.

PERCIVAL LOWELL.

In order to discover the best place or places for the location of telescopes in the future it is proposed to send observers furnished with similar instruments and identical instructions to all promising parts of the Earth's surface.

Two desert belts girdle the Earth in the sub-tropical regions of Capricorn and Cancer, and from the meteorological conditions there prevailing these belts offer the greatest promise to the astronomer. In the northern hemisphere the belt shows itself first in the Sahara of Africa, then in Arabia, then in the desert of Gobi and crossing the Pacific crops out again in Arizona and Mexico. Of these the two with the greatest height for their plateaux are Arizona and Mexico and the desert of Gobi. In the southern hemisphere we have the veldt of southern Africa, the western part of Australia, and finally the west coast of Peru and Bolivia. Of these the last is the highest and the Transvaal the next.

With regard to these places we have the most systematic series of records from Arizona, the next so from Peru, some slight knowledge of the Sahara, and next to none of any other locality.

Although the desert belts promise the best, other localities widely different should also be examined. Chief among these perhaps are the islands of the Pacific.

It is desirable, therefore, to send out observers somewhat as follows:

1. To the desert of Gobi.
2. To the veldt of the Transvaal.
3. To the Samoan Islands.

The observations made at these points could then be repeated elsewhere till the Earth's surface should be known from an astronomic point of view.

Each observer is to be armed with a 6-inch glass, all the glasses made by the same maker (for instance, Alvan Clark & Son's Corporation), and to report according to the proposed standard scale of "seeing."

It is thus important that the said scale should be agreed to by astronomers generally before the various expeditions start.

Monthly Notices, of the Royal Astronomical Society,
Vol. LXIII, No. 1, November 1902.

MEASURES OF THE RINGS OF THE PLANET SATURN.

F. E SEAGRAVE.

FOR POPULAR ASTRONOMY.

The enclosed measures of the distance between the inner edge of the inner bright ring (*B*) of Saturn and the planet itself, and also of the equatorial diameter of the planet were made here with the 8.25 Clark refractor during the summer of 1902. During the month of July and the first two weeks in August the seeing was generally so bad that no observations were made. From August 19th to October 12th there were fifteen nights when a power of 525 was used with fairly good results. On three or four nights the seeing was excellent especially during the twilight. In the year 1851 a startling theory was advanced by M. Struve of Pulkova in relation to the rings of Saturn, especially the inner rings. His theory was that while the diameter of the exterior ring remained constant the whole inner ring was spreading inward; and that the dark spaces between the ring (*B*) and the planet were continually growing smaller. The in-

vestigations of M. Struve depended largely upon the observations and measures of Huygens, Cassini and others taken from 210 to 225 years ago and with very feeble and comparatively imperfect telescopes. The drawings of the rings made by

MEASURES OF THE EQUATORIAL DIAMETER OF SATURN.

1902.	75 Merid. Time. h	m	Microm. Rev.	Sets.	Result. ″	Seeing.
Aug. 24	8	50	1.487	4	17.603	Good
25	9	20	1.481	4	17.553	Fair
31	8	40	1.477	5	17.632	Good
Sept. 2	9	20	1.481	5	17.726	Fair
7	8	10	1.466	4	17.667	Good, clouds
8	8	50	1.455	5	17.588	Excellent
10	8	20	1.464	6	17.718	Fair
14	6	50	1.439	4	17.522	Good
15	6	50	1.434	5	17.485	Bad, good later
23	7	50	1.418	5	17.111	Bad
Oct. 7	7	40	1.400	4	17.690	Good, twilight
8	6	50	1.404	5	17.770	Good, twilight
12	7	50	1.400	4	17.837	Fair
15	6	00	1.387	4	17.761	Bad
				Mean,	17.618	

A power of 525 was used all the time. Value of one revolution of micrometer screw = 24″.459. Measures made by double distances.

these astronomers show the width of the dark spaces a little greater than the combined width of the two bright rings. According to the best measures taken at the present time, the combined width of the two bright rings *A* and *B*, including the width of the Cassini division is about 7″.00, while the combined width of the dark space and ring (dusky ring) *C*, is only about 4″.00, or about 58 per cent. The principal difficulty in measuring such an object as the inner edge of ring *B*, or the outer edge of ring *C*, is that there is no sudden contrast between them. One seems to shade gradually into the other making it very difficult to determine where one begins and the other ends, and different observers will always secure different results. The following observations give a mean of 3″.698 as the distance between the inner edge of ring *B* (inner bright ring) and the limb of the planet, on the preceding side, and 4″.005 as the distance on the following side. The equatorial diameter of the planet measures 17″.618.

MEASURES OF DISTANCE FROM INNER EDGE OF RING B TO LIMB OF BALL OF SATURN.

1902.	75 Mer. T. h	m	Microm. Rev.	Sets.	Result. ″	Microm. Rev.	Sets.	Result. ″	Seeing.
Aug. 19	8	30	0.3072	5	3.649	0.3200	5	3.799	Good
24	8	00	0.3030	4	3.618	0.3230	4	3.855	Fair
25	8	30	0.2980	4	3.563	0.3200	4	3.824	Good
26	8	30	0.3010	4	3.603	0.3260	4	3.899	Fair
31	8	00	0.3081	4	3.709	0.3320	4	3.994	Good
Sept. 2	8	00	0.3080	4	3.718	0.3260	4	3.933	Fair
8	7	30	0.3120	4	3.794	0.3330	4	4.046	Excel't

MEASURES OF DISTANCE FROM INNER EDGE OF RING B TO LIMB OF BALL OF SÂTURN.—Continued.

1902.	75 Mer. T. h m	Microm. Rev.	Sets.	Result. ″	Microm. Rev.	Sets.	Result ″	Seeing.
10	7 30	0.3025	3	3.693	0.3320	3	4.049	Fair
14	8 00	0.3048	4	3.743	0.3380	4	4.146	Good
15	6 30	0.3084	4	3.792	0.3310	4	4.067	Bad
23	6 15	0.2987	4	3.719	0.3310	4	4.117	Bad
Oct. 6	6 30	0.2965	4	3.771	0.3320	4	4.218	Fair
7	6 30	0.2940	4	3.746	0.3230	4	4.112	Good
8	6 30	0.2907	3	3.711	0.3180	3	4.055	Good
12	6 00	0.2830	4	3.637	0.3090	4	3.968	Fair
			Mean,	3.6980		Mean,	4.0054	

A power of 525 was used all the time. Measures made by double distances.

Below are the results of measures of different standard observers taken during the past 75 years. Upon examining these measures there seems to be *no* uniform change here in the ratio of width of space between the limb of the planet and the inner edge of ring *B* divided by the combined width of the two bright rings, and on this account it also seems as if M. Struve's theory should be abandoned at least for the present.

PREVIOUS MEASURES.

Epoch.	Observer.	Combined Width of Rings A and B. ″	Combined Width of Dark Space and Ring C. ″	Ratio.
1826	W. Struve	6.73	4.34	0.65
1828	J. Herschel	7.76	3.57	0.47
1838	Encke	7.39	4.24	0.57
1851	O. Struve	7.43	3.67	0.49
1853	Jacob	6.80	4.18	0.61
1855	Secchi	7.55	4.03	0.53
1356	Jacob	6.87	4.14	0.60
1880	Meyer	7.08	4.42	0.62
1882	O. Struve	7.53	3.67	0.48
1885	A. Hall	7.35	4.02	0.55
1894	E. E. Barnard	7.36	3.89	0.53
1895	T. Lewis	7.37	4.11	0.55
1901	T. J. J. See	7.02	4.35	0.62

Corrected for irradiation.

PROVIDENCE, Feb. 5, 1903.

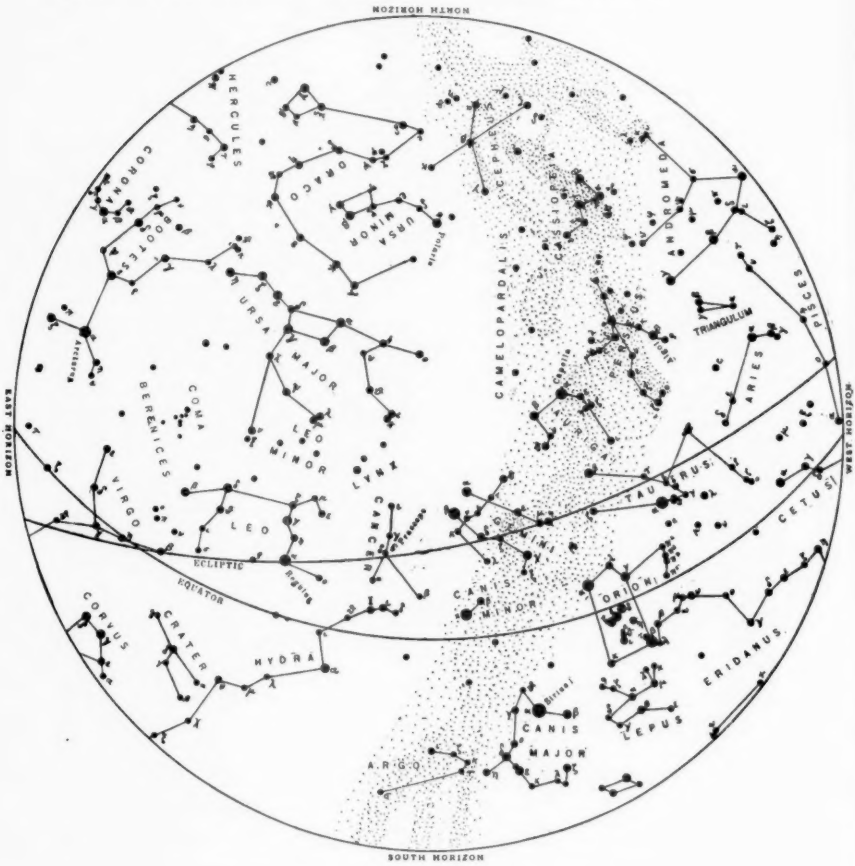
PLANET NOTES FOR MARCH AND APRIL.

H. C. WILSON.

Mercury during the first days of March will be visible in the east as morning star, but during the latter half of the month and through April will be invisible to the naked eye. On April 12, at 9 P. M., C. S. T., Mercury will be at superior conjunction with the Sun.

Venus is quite conspicuous now in the southwest an hour after sunset. During March and April the planet will move rapidly north until on May 1 it will be found quite near to the Pleiades. The brilliancy of the planet will increase only about one-half during the two months, but it will become much more conspicu-

ous because of its emergence from the bright twilight. The phase is gibbous, decreasing from 0.930 to 0.786 in the two months. Those who plan to study the surface markings of the planet should begin as soon as possible. These markings, if there are any real ones, are very difficult to see, consisting only of very vague shadings of the illuminated disc of the planet. Conjunctions of the Moon with Venus will occur on the nights of March 30 and April 29.



THE CONSTELLATIONS AT 9 P. M. MARCH 1, 1903.

Mars will be at opposition March 28 and so is in good position for observation. The planet is in the constellation Virgo, and its motion during the two months will be retrograde, northwest, crossing the equator March 29. The apparent diameter of the disc will increase from 13″.5 March 1, to 15″.8 April 1 and will then decrease to 14″.1 May 1. The distance of Mars from the Earth at opposition, April 1, will be a little over 59,000,000 miles.

Jupiter passed behind the Sun last month and so will be morning star but will not be at all conspicuous during the next two months. Jupiter and Mercury will be in conjunction March 18 at noon C. S. T.

Saturn also is morning star, farther out from the twilight and so more easily seen than Jupiter. On the morning of April 30 Saturn will reach quadrature, 90° west from the Sun.

Uranus will be at quadrature, 90° west from the Sun, on March 16. The planet can thus be readily observed with a telescope in the morning hours.

Neptune is visible with the aid of a telescope in the early evening, and will be at quadrature 90° east from the Sun, March 22. The planet will appear very nearly stationary among the stars during March, but during April it will move about 20′ or two-thirds of the diameter of the Moon toward the east. It is to be found a little over a degree to the west and 10′ to the south of the star η Geminorum.

Sunspots.—A new period of activity in sunspots has evidently begun. There have been several groups of small spots during the past three months and on Feb. 10 two rather large new spots were observed near the east limb of the Sun's disc. They had evidently been brought into view by the Sun's rotation their birth having occurred on the farther side of the globe. The two were of nearly the same size, in approximately the same north latitude separated by a considerable distance in longitude, and were surrounded by a large area of faculæ. On Feb. 17 they were beyond the central meridian of the solar disc and were both dying out.

The Moon.

		Phases.	Rises. (Central Standard Time at Northfield; Local Time 13m less.)		Sets. (Central Standard Time at Northfield; Local Time 13m less.)	
			h	m	h	m
Mar.	6-7	First Quarter	10	56 A. M.	2	03 A. M.
	12-13	Full Moon	5	39 P. M.	6	24 "
	20	Last Quarter.	1	01 A. M.	10	43 "
	28	New Moon	5	46 "	6	28 P. M.
Apr.	4-5	First Quarter	10	47 "	1	47 A. M.
	11-12	Full Moon	6	47 P. M.	5	58 "

Occultations Visible at Washington.

Date. 1903.	Star's Name.	Magnitude.	IMMERSION. Washington M.T. h	m	Angle from N pt. °	EMERSION. Washington M. T. h	m	Angle from N pt. °	Duration. h	m
Mar. 6	115 Tauri	5.4	12	49	81	13	39	287	0	50
8	λ Geminorum	3.6	7	54	112	9	13	271	1	19
13	B.A.C. 4134	6.0	16	55	99	17	57	300	1	02
13	B.A.C. 4135	6.0	16	57	98	17	58	301	1	01
Apr. 4	51 Geminorum	5.4	13	15	133	13	56	248	0	41
6	*a* Cancri	4.3	7	28	92	8	45	309	1	17
6	κ Cancri	5.0	13	12	156	13	50	241	0	38
10	B.A.C. 4294	6.1	15	29	92	16	30	305	1	01

An Annular Eclipse of the Sun March 28, 1903.—There will be an annular eclipse of the Sun on March 28, 1903, but it will not be visible in America, except in the extreme northwestern part. In Alaska and the western part of British America the Sun will be partially obscured just before sunset. The path of the annulus crosses the northern part of China, Siberia and the Arctic Ocean north of Alaska. The partial eclipse covers the greater part of Asia.

A Partial Eclipse of the Moon April 11,1903.—This will be nearly a total eclipse, 0.973 of the Moon's diameter being obscured at the middle of the eclipse. In North America the Moon will rise in eclipse and only the latter passing off of the shadow may be observed. In Europe, Africa and the eastern part of South America the whole eclipse may be witnessed. The following table gives the times of the different phases:

	Gr. M. T.		C. S. T.	
	h	m	h	m
Moon enters penumbra.....April 11	9	26.3	3	26.3 P. M.
Moon enters shadow.....	10	34.5	4	34.5 "
Middle of the eclipse.....	12	13.0	6	13.0 "
Moon leaves shadow.....	13	51.6	7	51.6 "
Moon leaves penumbra.....	14	59.8	8	59.8 "

Ephemeris for Physical Observations of the Sun.

[From the "Companion to the Observatory" for 1903.]

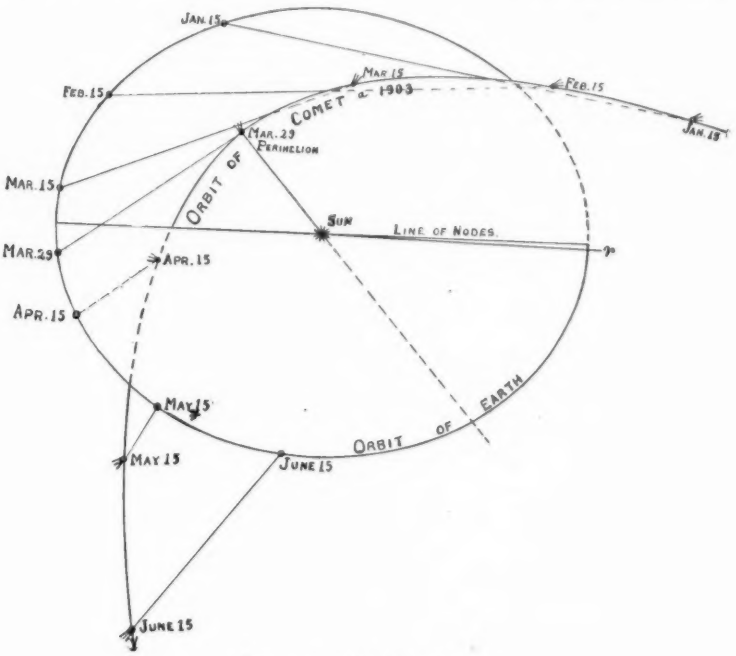
1903.	Greenwich Mean Noon. P.	D.	L.	1903.	Greenwich Mean Noon. P.	D.	L.
	° ′	° ′	° ′		° ′	° ′	° ′
Jan. 1	+ 2 15	−3 10	341 22	July 5	− 1 7	+3 26	59 37
6	− 0 11	3 44	275 32	10	+ 1 9	3 57	353 26
11	2 37	4 16	209 41	15	3 25	4 26	287 16
16	5 0	4 46	143 51	20	5 38	4 54	221 6
21	7 19	5 14	78 1	25	7 47	5 20	154 58
26	9 33	5 39	12 11	30	9 53	5 43	88 50
31	11 42	6 2	306 21	Aug. 4	11 54	6 4	22 42
Feb. 5	13 44	6 22	240 31	9	13 49	6 23	316 34
10	15 38	6 39	174 41	14	15 37	6 39	250 29
15	17 25	6 53	108 51	19	17 19	6 52	184 24
20	19 3	7 3	43 0	24	18 53	7 2	118 20
25	20 32	7 10	337 9	29	20 19	7 10	52 17
Mar. 2	21 52	7 14	271 18	Sept. 3	21 40	7 14	346 14
7	23 2	7 14	205 26	8	22 48	7 15	280 12
12	24 2	7 12	139 33	13	23 49	7 13	214 11
17	24 53	7 6	73 38	18	24 40	7 8	148 10
22	25 33	6 56	7 43	23	25 23	6 59	82 11
27	26 3	6 44	301 47	28	25 55	6 48	16 12
Apr. 1	26 22	6 29	235 49	Oct. 3	26 17	6 34	310 13
6	26 30	6 11	169 51	8	26 29	6 17	244 14
11	26 27	5 50	103 50	13	26 29	5 56	178 16
16	26 13	5 26	37 49	18	26 18	5 33	112 19
21	25 48	5 1	331 47	23	25 56	5 8	46 23
26	25 12	4 33	265 44	28	25 22	4 40	340 27
May 1	24 25	4 3	199 40	Nov. 2	24 36	4 10	274 30
6	23 27	3 32	133 34	7	23 39	3 38	208 34
11	22 19	2 59	67 27	12	22 29	3 4	142 39
16	21 0	2 26	1 20	17	21 8	2 29	76 45
21	19 31	1 51	295 11	22	19 36	1 52	10 51
26	17 53	1 15	229 1	27	17 53	1 15	304 56
31	16 7	0 39	162 51	Dec. 2	16 1	+0 37	239 2
June 5	14 13	−0 3	96 41	7	13 59	−0 2	173 9
10	12 13	+0 32	30 31	12	11 50	0 40	107 17
15	10 6	1 9	324 21	17	9 34	1 18	41 25
20	7 55	1 44	258 10	22	7 13	1 56	335 33
25	5 41	2 19	191 59	27	4 49	2 32	269 41
30	3 24	2 53	125 48	32	+ 2 22	−3 8	203 49

The position-angle of the Sun's axis, P, is the position-angle of the N. end of the axis from the N. point of the Sun, read in the direction N., E., S., W. In computing D (the heliographic latitude of the center of the Sun's disk), the inclination of the Sun's axis to the ecliptic has been assumed to be 82° 45′, and the

longitude of the ascending node to be 74° 24′. In computing L (the heliographic longitude of the center of the disk), the Sun's period of rotation has been assumed to be 25.38 days, and the meridian which passed through the ascending node at the epoch 1854.0 has been taken as the zero meridian.

COMET AND ASTEROID NOTES.

Three Comets.—Three comets are now visible in the evening sky, all, however, faint at the present time and requiring the use of a good telescope in order that they may be seen. Comet *b*, 1902, discovered by Perrine on Sept. 1, has since that time completed nearly three-quarters of the circuit of the heavens, and is now returning from the southern hemisphere of the sky to the northern. On March 1 it will be about 5° north and 1° west of Sirius, and will move in a



COMET *a*, 1903 (GIACOBINI).

northwesterly direction. No ephemeris is at hand beyond March 3, when the position is, R. A. $6^h\ 34^m\ 46^s$; Decl. $-10°\ 56'.5$. The calculated brightness then is 0.6 of that at the time of discovery, but as observed by the writer on the evening of Feb. 19 the comet seemed already fainter than in September, whereas its brightness should have been about the same. There was a very small central condensation surrounded by diffuse nebulosity 10′ or more in diameter. The faint nebulosity could be seen better in the 5-inch than in the 16-inch telescope.

Comet *d* 1902 is extremely small for a comet and can scarcely be detected in a five-inch telescope. It is nearly over head, in the constellation Gemini, at 8 o'clock in the evening.

Comet *a* 1903 is in the western sky after sunset and is rapidly growing brighter. It will probably not become visible to the naked eye, but may become a conspicuous telescopic object to observers in the southern hemisphere in May.

Comet *a*, 1903 (Giacobini.)—Elements of this comet are given by H. Kreutz in *A. N.* 3844 and G. Fayet in *A. N.* 3845. They agree in indicating that the comet will increase rapidly in brightness. The Sun is, however, gaining on it in right ascension, so that the brightening twilight in which the comet must be observed will offset its increase in brilliancy.

ELEMENTS OF COMET *a*, 1903.

Computer Kreutz.	Fayet.
$T = 1903$ Mar. 14.875 Berlin M. T.	Mar. 28.9468 Paris M. T.
$\omega = 133°\ 37'.0$	$130°\ 40'\ 55''$
$\Omega = 2\ 32.5$	$0\ 41\ 56$ 1903.0
$i = 30\ 29.9$	$33\ 35\ 6$
$\log q = 0.61124$	9.67479

On March 1 the comet will be near the star γ Pegasi, at the southeastern corner of the Square of Pegasus. Its motion is northeasterly. The accompanying diagram shows the relative positions of the comet and Earth from Jan 15, the date of discovery, to June 15. In order to get the true perspective the reader must imagine the orbit of the Earth to be inclined 33° to the plane of the paper or of the comet's orbit, the upper part being tilted back and the lower part tilted forward, in front of the comet's path. It will thus be seen that when the comet was discovered it was nearly twice as far from the Earth as the Earth is from the Sun, and that it is rapidly approaching both the Earth and Sun. The movement of the two is such that the line joining them is gradually approaching the Sun. The comet will reach perihelion March 29 and after that time it will move rapidly south. The nearest approach to the Earth will be about the first of May when it will be something like thirty million miles distant and may be quite conspicuous. It will then probably be visible only in the southern hemisphere.

Transparency of Comet 1902 *b*.—The statement is frequently made that comets are perfectly transparent, even faint stars being visible through them. The observations on which this statement is based appear to be very vague, as even if careful comparisons were made large errors might be introduced by the effect of the bright background formed by the light of the comet. The rapid motion of Comet 1902 *b* caused it to cover a large area and therefore rendered it easier to find a star over which it would pass. After waiting for a suitable occasion, the observations given in Table I were made by Professor O. C. Wendell with the polarizing photometer attached to the 15-inch equatorial. On the evening of October 14, 1902, the comet passed within about 1′ of the star + 21°3483 photometric magnitude 7.12. This star was compared with + 21°3484, magnitude 8.19. Each set of observations was the mean of sixteen settings. The Greenwich Mean Time is given in the first column, the difference in magnitude of the two stars in the second, and the deviation of this magnitude from the mean value, 1.07, in the third column. A positive sign indicates that the star + 21°3483 was faint, a negative sign that it was bright. The fourth column gives the distance of the nucleus of the comet from the star. The diameter of the

coma was about five or six minutes. The star was, therefore, covered by it in the first three observations. The nucleus resembled a star of about the tenth magnitude and the brightness of the coma was about that of a star of the ninth magnitude when spread over a circle one minute in diameter. The largest residual — 0.05 is the last one, when the altitude of the comet was only 22°. The mean of all the residuals is ± 0.02. It appears, therefore, that the absorption of the light by the comet, if any, is insensible, and probably does not exceed one or two hundredths of a magnitude

TABLE I.—OBSERVATIONS.

Gr. M. T. h m	Difference,	Residuals.	Distance. ′
13 22.5	1.06	+ .01	2.0
13 33.3	1.03	+ .04	1.1
13 44.7	1.10	— .03	2.0
13 57.7	1.07	.00	4.0
14 10.8	1.06	+ .01	5.5
14 26.7	1.06	+ .01	7.9
14 46.9	1.08	— .01	11.0
15 2.3	1.12	— .05	13.1

Asteroids.—Trails of a large number of asteroids appear upon the Bruce plates, in one case no less than seven being photographed on a single plate. A list of these is in course of preparation. The positions of three of those recently found, the first by Professor Bailey, the last two by Mr. Frost, are given in Table II. The date, the Greenwich Mean Time, the right ascension for 1875, and the declination for 1875, are given in the successive columns.

TABLE II.—POSITIONS OF ASTEROIDS.

Ast.	Date.	Gr. M. T. h m	R. A. 1875. h m s	Decl. 1875. ° ′
1	July 30 1902	15 54	19 45 30	— 22 14.0
"	" 1 "	15 46	19 44 46	— 22 22.9
"	" 2 "	15 46	19 44 0	— 22 31.8
"	" 3 "	16 13	19 43 12	— 22 40.8
"	Aug. 21 "	12 24	19 6 52	— 28 59.4
"	Sept. 2 "	15 11	19 6 35	— 29 46.4
"	" 22 "	13 24	19 17 17	— 30 21.3
"	" 30 "	13 2	19 24 57	— 30 21.8
"	Oct. 22 "	12 40	19 54 19	— 29 43.9
2	Aug. 21 "	12 24	19 16 6	— 29 3.9
"	Sept. 2 "	15 11	19 11 44	— 29 16.0
"	" 22 "	13 24	19 13 22	— 29 11.2
"	" 30 "	13 2	19 16 59	— 29 2.6
"	Oct. 21 "	13 2	19 33 18	— 28 22.6
3	" 21 "	13 2	19 31 48	— 29 11.1

No asteroids are given in the Berlin Jahrbuch for 1904 in the positions of Nos. 1 and 2. Vesta was, of course, a conspicuous object on several of the photographs.

EDWARD C. PICKERING.

Harvard College Observatory, *Circular*, No. 68,
January 27, 1903.

The Return of the Periodic Comet 1896 VII (Perrine).—In *A. N.* 3841 Mr. Ristenpart gives elements corrected for perturbations by Jupiter and reduced to 1903, as follows:

Epoch = Jan. 29.0, 1903 Berlin M. T.
Perihelion = April 26.6, 1903

L =	35° 50′.84		ϕ = 41° 45′.75
π =	49 04 .02	1903.0	μ = 543″.733
Ω =	242 20 .40		log a = 0.54313
i =	15 41 .28		

The following search ephemeris, computed from these elements, shows that the comet is very unfavorably placed for observation so that its detection at this return is practically hopeless:

SEARCH EPHEMERIS FOR COMET 1896 VII PERRINE.

1903.	R. A.	Decl.	log r	log Δ	Br.	Comet. $\Delta\alpha$	Sun. $\Delta\delta$
	h m	° ′				h m	°
Jan. 21.5	21 23.2	— 4 33	0.2179	0.4015	0.17	+ 1 11	+ 15.4
29.5	21 44.1	— 3 05	0.2010	0.3929	0.20	+ 0 59	+ 15.0
Feb. 6.5	22 05.9	— 1 27	0.1840	0.3856	0 22	+ 0 48	+ 14.3
14.5	22 28.0	+ 0 21	0.1670	0.3780	0.25	+ 0 39	+ 13.7
22.5	22 52.5	+ 2 17	0.1501	0.3703	0.28	+ 0 32	+ 12.6
Mar. 2.5	23 17.4	+ 4 20	0.1337	0.3627	0.31	+ 0 27	+ 11.7
Apr. 3.5	1 9.0	+ 12 47	0.0806	0.3385	0.44	+ 0 22	+ 7.7
May 5.5	3 12.7	+ 18 49	0.0690	0.3354	0.47	+ 0 25	+ 2.7
June 6.5	5 25.0	+ 19 27	0.1070	0.3576	0.36	— 0 30	— 3.1
July 8.5	7 15.3	+ 15 17	0.1710	0.3952	0.23	— 0 08	— 7.2
Aug. 9.5	8 43.2	+ 8 48	0.2382	0.4342	0.14	— 0 31	— 7.2
Sept. 10.5	9 52.7	+ 1 44	0.2994	0.4635	0.09	— 1 20	— 3.4
Oct. 12.5	10 48.3	— 5 4	0.3528	0.4770	0.07	— 2 20	+ 2.2
Nov. 13.5	11 31.5	— 11 14	0.3991	0.4720	0.06	— 3 40	+ 6.6

The brightness is given in units of that which the comet had when last seen at Northfield in 1897 with the 16-inch telescope. It was described then as "most exceedingly faint but certainly seen,"

Comet *d*, 1902.—Elements and an Ephemeris by Ristenpart are given in *A*, *N*. 3841. The comet is very small and inconspicuous even in a telescope. During March it will decrease slowly in brightness and its course will be northeasterly in the constellation Gemini.

ELEMENTS.

T = 1903 March 22.86660 Berlin M. T.
ω = 5° 35′ 17″.7
Ω = 117 27 35 .5 } 1903.0
i = 43 55 26 .9
log q = 0.443683

EPHEMERIS.

1903.	α 1903.0	δ 1903.0	log r	log Δ
	h m s	° ′ ″		
Mar. 5	6 38 26.88	+ 23 28 25.3	0.4446	0.3464
6	38 47.38	23 43 36.3		
7	39 9.50	23 58 35.6		
8	39 33.23	24 13 23.5		
9	39 58.57	24 27 59.9	0.4442	0.3556
10	40 25.49	24 42 24.6		
11	40 53.99	24 56 37.8		
12	41 24.06	25 10 39.5		
13	41 55.69	25 24 29.8	0.4439	0.3650
14	42 28.87	25 38 8.9		
15	43 3.59	25 51 36.7		
16	43 39.83	26 4 53.0		
17	44 17.58	26 17 57.9	0.4438	0.3745
18	44 56.83	26 30 51.2		
19	45 37.58	26 43 33.2		
20	46 19.80	26 56 3.9		
21	47 3.49	27 8 23.5	0.4437	0.3840
22	47 48.63	27 20 31.9		
23	48 35.20	27 32 29.2		
24	49 23.20	27 44 15.5		

	25		50	12.61		27	55	50.8	0.4437	0.3935
	26		51	3.42		28	7	15.3		
	27		51	55.62		28	18	28.8		
	28		52	49.19		28	29	31.4		
	29		53	44.11		28	40	23.0	0.4438	0.4049
	30		54	40.37		28	51	3.3		
	31		55	37.96		29	1	33.0		
Apr.	1		56	36.86		29	11	51.5		
	2	6	57	37.06	+	29	21	59.0	0.4440	0.4123

New Asteroids.—The following have been added to the list of new planets since our last note:

	Discoverer.	Place.	Local M. T.	R. A.	Decl.	Mag.
			h m	h m s	° ′ ″	
1902	LA Wolf	Heidelberg	Jan. 16 6 56.0	6 52.4	+ 23 50 02	12.5
	LB "	"	18 7 20.5	8 34.0	+ 44 40	14.0
	LC "	"	19 9 30.5	5 44.1	— 0 24	13.0
	LD "	"	18 10 54.5	8 24.0	+ 18 50	12.5
	LE "	"	18 10 54.5	8 40.4	+ 20 24	13
	LF Dugan	"	19 8 58.0	9 02.8	+ 24 33	11.3
	LG "	"	22 9 55.6	9 02.4	+ 15 33	11.2

LB is possibly identical with (475) Ocllo.

VARIABLE STARS.

Observations of Nova Persei.

Eastern Standard Time.					J. Day.	Comparison.	Remarks.
	M	D	h	m			
1902	10	29	8	30	2416052	p 1½ V 1½q	
	11	1	8	30	6055	p 1 V 1½ q	
			8	50		p 1½ V 1½ q	
		2	8	05	6056	p 1 V 2 q	
		4	8	30	6058	p ½ V 3 q	
		19	7	45	6073	q ½ V 2½ r	
		20	8	10	6074	var = q	
		23	8	00	6077	p 2 V 1 q	
	12	1	7	40	6085	var = q	
1903	2	3	8	30	6149	q 2 V 2½ r	
	2	7	7	30	6153	q 2 V 2½r	Moonlight haze
		9	7	30	6156	q 2½ V 2½ r	Moonlight
		10	7	40	6156	q 3 V 2 r	"
			8	05		q 3 V 2 r	
		14	6	50	6160	q 3 V 2 r	Sky clear and dark
			9	30		q 3½ V 2 r	

Can it be possible that star q or r is variable? On Nov. 19 the difference in brightness between q and r was about 3/10 of a magnitude. On Feb. 3, 1903 the difference was 6/10. Can this be an error in making the comparisons or is it real?

F. E. SEAGRAVE.

The stars p, q and r are Nos. 32, 33 and 34 of Hagen's Chart II, BD + 43°743, 760 and 735. Their magnitudes are given in the BD as 9.2, 9.4 and 9.5 and by Hagen as 9.4, 9.5 and 9.6.

H. C. W.

Minima of Variable Stars of the Algol Type.

[Greenwich Mean Time beginning with midnight. The hours greater than 12 are those of the afternoon. To obtain Eastern Standard time subtract 5 hours; for Central Standard subtract 6 hours, etc.]

U Cephei.

	d	h
Mar.	3	1
	5	12
	8	0
	10	12
	13	0
	15	12
	18	0
	20	11
	22	23
	25	11
	27	23
	30	11
Apr.	1	23
	4	10
	6	22
	9	10
	11	22
	14	10

Z Persei

Mar.	1	6
	4	7
	7	9
	10	10
	13	11
	16	13
	19	14
	22	16
	25	17
	28	18
	31	20
Apr.	3	21
	6	23
	10	0
	13	1

Algol.

Mar.	3	12
	6	9
	9	6
	12	3
	15	0
	17	20
	20	17
	23	14
	26	11
	29	8
Apr.	1	5
	4	1
	6	22
	9	19
	12	16
	15	13

λ Tauri.

Mar.	4	17
	8	16
	12	15
	16	14
	20	12
	24	11
	28	10
Apr.	1	9
	5	8
	9	7
	13	6

R Canis Majoris

Mar.	1	8
	2	11
	3	15
	4	18
	5	21
	7	0
	8	4
	9	7
	10	10
	11	13
	12	17
	13	20
	14	23
	16	2
	17	6
	18	9
	19	12
	20	15
	21	19
	22	22
	24	1
	25	5
	26	8
	27	11
	28	15
	29	17
	30	21
Apr.	1	0
	2	3
	3	7
	4	10
	5	13
	6	16
	7	20
	8	23
	10	2
	11	5
	12	9
	13	12
	14	15

RR (R^2) Puppis

Mar.	5	19
	12	5
	18	15
	25	2
Mar.	31	12
Apr.	6	22
	13	9

V Puppis

Mar.	1	3
	2	14
	4	0
	5	11
	6	22
	8	9
	9	20
	11	7
	12	18
	14	5
	15	16
	17	3
	18	14
	20	0
	21	11
	22	22
	24	9
	25	20
	27	7
	28	18
	30	5
	31	16
Apr.	2	3
	3	14
	5	0
	6	11
	7	22
	9	9
	10	20
	12	7
	13	19

S Cancri.

Mar.	2	11
	11	23
	22	11
	30	22
Apr.	9	10

S Antliæ.

Period $7^h\ 46^m.8$

Mar.	1	9
	2	8
	3	8
	4	7
	5	6
	6	6
	7	5
	8	4
	9	4
	10	3
	11	2
	12	2

S Antliæ.

Mar.	13	1
	14	0
	15	0
	15	23
	16	23
	17	22
	18	21
	19	21
	20	20
	21	19
	22	19
	23	18
	24	17
	25	17
	26	16
	27	15
	28	15
	29	14
	30	13
	31	13
Apr.	1	12
	2	11
	3	11
	4	10
	5	9
	6	9
	7	8
	8	7
	9	7
	10	6
	11	5
	12	5
	13	4
	14	3

S Velorum.

Mar.	4	17
	10	15
	16	14
	22	12
	28	10
Apr.	3	9
	9	7
	15	6

δ Libræ.

Mar.	1	18
	4	0
	6	8
	8	16
	11	0
	13	8
	15	16
	17	23
	20	7
	22	15
	24	23

δ Librae.

Mar.	27	7
	29	15
	31	23
Apr.	3	6
	5	14
	7	22
	10	6
	12	14
	14	22

U Coronæ.

Mar.	1	6
	4	17
	8	4
	11	15
	15	1
	18	12
	21	23
	25	10
	28	21
Apr.	1	8
	4	18
	8	5
	11	16

R Aræ.

Mar.	2	8
	6	18
	11	5
	15	15
	20	1
	24	11
	28	21
Apr.	2	8
	6	19
	11	4

U Ophiuchi.

Mar.	1	12
	2	8
	3	4
	4	1
	4	21
	5	17
	6	13
	7	9
	8	5
	9	1
	9	21
	10	18
	11	14
	12	10
	13	6
	14	2
	14	22
	15	18
	16	14

Minima of Variable Stars of the Algol Type.—Continued.

U Ophiuchi.

	d	h
Mar.	17	11
	18	7
	19	3
	19	23
	20	19
	21	15
	22	11
	23	8
	24	4
	25	0
	25	20
	26	16
	27	12
	28	8
	29	4
	30	1
	30	21
	31	17
Apr.	1	13
	2	9
	3	5
	4	1
	4	21
	5	18
	6	14
	7	10
	8	6
	9	2
	9	22
	10	18
	11	14
	12	11
	13	7
	14	3

Z Herculis.

	d	h
Mar.	1	5
	3	6
	5	5
	7	6
	9	5
	11	6
	13	5
	15	6
	17	5

Z Herculis.

	d	h
Mar.	19	6
	21	5
	23	5
	25	4
	27	5
	29	4
	31	5
Apr.	2	4
	4	5
	6	4
	8	5
	10	4
	12	4
	14	3

RX (X^2) Herculis.

	d	h
	1	18
	2	15
	3	13
	4	10
	5	7
	6	5
	7	2
	8	0
	8	21
	9	18
	10	15
	11	13
	12	10
	13	7
	14	5
	15	2
	15	23
	16	21
	17	18
	18	15
	19	12
	20	10
	21	7
	22	4
	23	2
	23	23
	24	20
	25	18

RX (X^2) Her.

	d	h
Mar.	26	15
	27	12
	28	10
	29	7
	30	4
	31	2
	31	23
Apr.	1	20
	2	18
	3	15
	4	12
	5	10
	6	7
	7	4
	8	2
	8	23
	9	20
	10	18
	11	15
	12	12
	13	10
	14	7

RV (V^2) Lyrae.

	d	h
Mar.	2	22
	6	13
	10	3
	13	17
	17	8
	20	22
	24	13
	28	3
	31	17
Apr.	4	8
	7	22
	11	12
	15	3

U Sagittae.

	d	h
Mar.	3	14
	7	0
	10	9
	13	18
	17	3
	20	12

U Sagittae.

	d	h
Mar.	23	21
	27	6
	30	15
Apr.	3	0
	6	10
	9	19
	13	4

SY (X^3) Cygni.

	d	h
Mar.	2	16
	8	16
	14	16
	20	16
	26	16
Apr.	1	17
	7	17
	13	17

SW (V^3) Cygni.

	d	h
Mar.	3	17
	8	7
	12	20
	17	10
	22	0
	26	14
	31	3
Apr.	4	17
	9	7
	13	21

UW (Z^4) Cygni.

	d	h
Mar.	3	16
	7	3
	10	14
	14	1
	17	12
	20	23
	24	9
	27	20
	31	7
Apr.	3	18
	7	5
	10	15
	14	2

W Delphini.

	d	h
Mar.	5	18
	10	13
	15	9
	20	4
	24	3
	29	19
Apr.	3	14
	8	9
	13	5

Y Cygni.

	d	h
Mar.	2	3
	3	19
	5	3
	6	19
	8	3
	9	19
	11	3
	12	19
	14	3
	15	18
	17	3
	18	18
	20	3
	21	18
	23	2
	24	18
	26	2
	27	18
	29	2
	30	18
Apr.	1	2
	2	18
	4	2
	5	18
	7	2
	8	18
	10	2
	11	18
	13	2
	14	18

Maxima of UY (S^5) Cygni.

Period $13^h\ 26^m.3$. The minimum occurs $1^h\ 55^m$ before the maximum.

	h
Mar. 1	16
2	19
3	22
5	1
6	3
7	6
8	9
9	12
10	15
11	18
12	21
14	0
15	2
16	5
17	8
18	11
19	14
20	17
21	20
22	23
24	1
25	4
26	7
27	10
28	13
29	16
30	19
31	22
Apr. 2	0
3	3
4	6
5	9
6	12
7	15
8	18
9	21
10	23
12	2
13	5
14	8

Variable Stars of Short Period not of the Algol Type.

	Minimum.	h	Maximum.	h
V Velorum	Mar. 1	2	Mar. 2	1
S Muscae	1	10	4	21
W Geminorum	1	12	3	3
δ Cephei	2	0	3	15
S Normae	2	8	6	18
V Carinae	2	16	4	20
RV Scorpii	2	23	4	9
T Velorum	3	1	4	10
U Vulpeculæ	3	17	5	20
T Vulpeculæ	3	23	5	8
T Crucis	3	23	6	0
β Lyræ	4	3	7	5
V Centauri	4	7	5	18
SU Cygni	4	16	6	0
S Crucis	4	16	6	4
S Trianguli	4	23	7	1
V Velorum	5	11	6	10
R Crucis	5	20	7	5
ζ Geminorum	6	2	11	2
κ Pavonis	6	8	10	3
U Aquilae	7	0	9	4
δ Cephei	7	9	9	0
T Velorum	7	16	9	1
X Cygni	7	17	14	12
S Sagittae	7	17	11	3
η Aquilae	7	19	10	1
T Vulpeculae	8	10	9	19
SU Cygni	8	12	9	20
RV Scorpii	9	0	10	10
W Geminorum	9	5	11	20
V Carinae	9	9	11	13
V Centauri	9	19	11	6
V Velorum	9	20	10	19
S Crucis	10	8	11	20
TX Cygni	10	11	15	18
β Lyræ	10	14	13	21
T Crucis	10	17	12	18
S Muscae	11	2	14	13
S Trianguli	11	7	13	9
R Crucis	11	15	13	0
U Vulpeculae	11	17	13	20
T Velorum	12	1	13	10
S Normae	12	2	16	12
SU Cygni	12	9	13	17
δ Cephei	12	18	14	9
T Vulpeculae	12	20	14	5
Y Ophiuchi	13	10	19	15
U Aquilae	14	1	16	5
V Velorum	14	5	15	4
η Aquilae	15	0	17	6
RV Scorpii	15	2	16	12
S Crucis	15	1	16	13
V Centauri	15	7	16	18
W Virginis	15	7	23	12
κ Pavonis	15	10	19	5
S Sagittae	16	2	19	12
V Carinae	16	2	18	6
T Monocerotis	16	4	24	2
SU Cygni	16	5	17	13
ζ Geminorum	16	6	21	6
W Geminorum	16	23	19	14

	Minimum.	h	Maximum.	h
R Crucis	Mar. 16	11	Mar. 17	20
T Velorum	16	23	18	8
β Lyræ	17	1	20	4
T Vulpeculæ	17	7	18	16
T Crucis	17	10	19	11
S Trianguli	17	14	19	16
δ Cephei	18	3	19	18
V Velorum	18	14	19	13
U Vulpeculæ	19	16	21	19
S Crucis	19	17	21	5
SU Cygni	20	1	21	9
V Centauri	20	18	22	5
S Muscae	20	18	24	5
U Aquilae	21	1	23	5
RV Scorpii	21	3	22	13
T Velorum	21	14	22	23
T Vulpeculæ	21	17	23	2
S Normae	21	21	26	7
η Aquilae	22	4	24	10
V Carinae	22	18	24	22
V Velorum	23	23	23	22
R Crucis	23	7	24	16
δ Cephei	23	11	25	2
β Lyræ	23	12	27	19
SU Cygni	23	21	25	5
S Trianguli	23	22	26	0
X Cygni	24	2	30	21
T Crucis	24	4	26	5
S Crucis	24	10	25	22
S Sagittae	24	12	27	21
κ Pavonis	24	12	28	7
W Geminorum	24	17	27	8
T Vulpeculæ	26	4	27	13
TX Cygni	25	5	30	8
V Centauri	26	6	27	17
T Velorum	26	6	27	15
ζ Geminorum	26	9	31	9
RV Scorpii	27	5	28	15
V Velorum	27	8	28	7
U Vulpeculae	27	16	29	19
SU Cygni	27	18	29	2
U Aquilae	28	2	30	6
δ Cephei	28	20	30	11
S Crucis	29	2	31	14
R Crucis	29	3	30	12
η Aquilae	29	8	31	14
β Lyrae	29	23	Ap..	1 1
V Carinae	29	11	Mar.	31 15
S Trianguli	30	6	Apr.	1 8
S Muscae	30	9		2 20
Y Ophiuchi	30	13		5 18
T Vulpeculae	30	14	Mar.	31 23
T Velorum	30	21	Apr.	1 6
T Crucis	30	21		2 22
SU Cygni	31	14		1 22
S Normae	31	15		5 1
V Velorum	31	17		1 16
V Centauri	31	18		2 5
W Geminorum	Apr. 1	11		4 2
W Virginis	1	14		9 19
S Sagittae	1	20		5 6

	Minimum.		Maximum.	
		h		h
S Crucis	Apr. 2	6	Apr. 3	18
RV Scorpii	2	6	3	16
κ Pavonis	2	15	6	10
δ Cephei	3	5	4	20
R Crucis	3	23	5	8
T Vulpeculae	4	0	5	9
U Aquilae	4	3	6	7
SU Cygni	4	11	5	18
T Velorum	4	13	5	22
U Vulpeculae	4	15	6	18
V Velorum	5	2	6	1
V Carinae	5	4	7	8
β Lyrae	5	10	8	17
η Aquilae	5	12	7	18
ζ Geminorum	5	13	10	13
S Trianguli	5	14	7	16
V Centauri	6	6	7	17
T Crucis	6	15	8	16
S Crucis	7	11	8	23
SU Cygni	8	7	9	15
RV Scorpii	8	8	9	18
T Vulpeculae	8	11	9	20
δ Cephei	8	14	10	5
TX Cygni	8	22	14	1
S Muscae	Apr. 9	1	Apr. 12	12
T Velorum	9	4	10	13
W Geminorum	9	4	11	19
V Velorum	9	10	10	9
X Cygni	9	11	16	6
R Crucis	9	19	11	4
S Sagittae	10	6	13	16
S Normae	10	9	14	19
U Aquilae	11	3	13	7
κ Pavonis	11	17	15	12
V Centauri	11	18	13	5
S Trianguli	11	21	13	23
V Carinae	11	21	14	1
SU Cygni	12	3	13	11
β Lyrae	11	21	14	23
S Crucis	12	4	13	16
T Monocerotis	12	4	20	2
U Vulpeculae	12	15	14	18
η Aquilae	12	17	14	23
T Vulpeculae	12	21	14	6
T Crucis	13	9	15	10
V Velorum	13	19	14	18
T Velorum	13	19	15	4
δ Cephei	13	23	15	14

Maxima and Minima of Long Period Variables.

[Computed from Chandler's "Third Catalogue." A question mark indicates that the elements are in doubt. By Misses Ida I. Watson and Helen M. Swartz of Vassar College Observatory.]

Maxima.

Date Mar.	No.	Star.
2	7733	Y Capricorni
3	6943?	T Sagittae
4	5758	X Herculis
5	7261?	R Delphini
6	7299	U Cygni
6	8373	S Pegasi
7	5438?	Y Librae
7	5583	X Libræ
8	5795	W Scorpii
9	5830	R Scorpii
11	466	U Piscium
12	7428	V Cygni
13	906	R Trianguli
14	432	S Cassiopeiae
14	1855	R Aurigæ
16	5174	RS Virginis
18	5675	V Coronae
20	5831	S Scorpii
21	7609	T Cephei
22	5593	W Librae
22	7242	S Aquilae
23	7155?	RR Aquilae
27	3184	T Hydrae
27	7252	W Capricorni
28	2258	V Aurigae
28	3567	V Leonis
29	8597	V Ceti
30	976	T Arietis
30	7560	R Vulpeculae
Apr. 2	5601	S Ursae Minoris

Maxima.

Date. Apr.	No.	Star.
6	7456?	RR Cygni
7	294?	W Cassiopeiae
7	1577	R Tauri
8	7754	W Cygni
10	6849	R Aquilae
11	4407	R Corvi
14	7431	S Delphini
16	845	R Ceti
16	5617?	U Librae
18	5856	W Ophiuchi
21	1582	S Tauri
22	2013	U Aurigae
22	806	o Ceti
24	7571	V Capricorni
26	8324	V Cassiopeiae
28	4596	U Virginis

Minima.

Mar.		
4	2625	V Geminorum
6	1805?	V Orionis
8	5955	R Draconis
9	782	R Arietis
14	513	R Piscium
14	7779	S Cephei
20	5677	R Serpentis
21	1717	V Tauri
21	2735	U Canis Minoris
25	2213	η Geminorum
30	3477	R Leonis Minoris
Apr. 4	1981	S Camelopardalis

Maxima and Minima of Long Period Variables.—Continued.

Minima.			Minima.		
Date. Apr.	No.	Star.	Date. Apr.	No.	Star.
5	3994	S Leonis	22	7659	T Capricorni
6	5758	X Herculis	25	8600	R Cassiopeiae
11	5190	R Camelopardalis	29	4492	Y Virginis
20	243	U Cassiopeiae	29	5194	V Bootis
21	8591	V Cephei	40	2742	S Geminorum
22	114	S Ceti			

GENERAL NOTES.

Chandler's Probable Value of the Constant of Aberration.—The most important paper that has lately appeared is that by S. C. Chandler on the probable value of the constant of aberration. It was given in Vol. 23, No. 1 of the *Astronomical Journal.* He speaks of Struve's work 50 years ago and how Nyren unsettled it in 1883, and how Doolittle disturbed it still more later, and the useless attempt of Almanac legislation to settle the matter in 1896. During all this time work on this constant has been going on, and what ever differences of judgment individual astronomers may have about the right weight to attach to the various determinations that have been made, it will matter little, because the influence will be small on the general result in consequence of so much available data for comparison.

In this view of the matter, Chandler is right, and it is somewhat surprising, as *The Observatory* well remarks, the conference in Paris in 1896 should have adopted values for the beginning of the century, for aberration 20″.47 and for parallax 8″.80, when these data at that time were known to be uncertain. If the changes then made had waited a little, it certainly would have been better.

Confidence is felt in the result reached by Mr. Chandler, not only because of the close attention which he has given to this matter during the last ten years, but also because of the larger range of data involved in the discussion and the thoroughness with which the work has been done.

The final result obtained for the aberration constant by Mr. Chandler's recent work is 20″.517 "only 0″.04 smaller than the one (20″.521) which has been derived as a definitive result of this investigation, by an exercise of a crucial choice demanded by the circumstances for the purpose of arriving at the most acceptable result." In all this work Mr. Chandler has used his judgment in weighing results by different methods, and he has set out this fact in the discussion fully and well.

By referring to this paper those interested will readily see what steps may be taken to use this new value in place of Struve's constant (20″.445) or that of the Paris Conference of 1896 (20″.47).

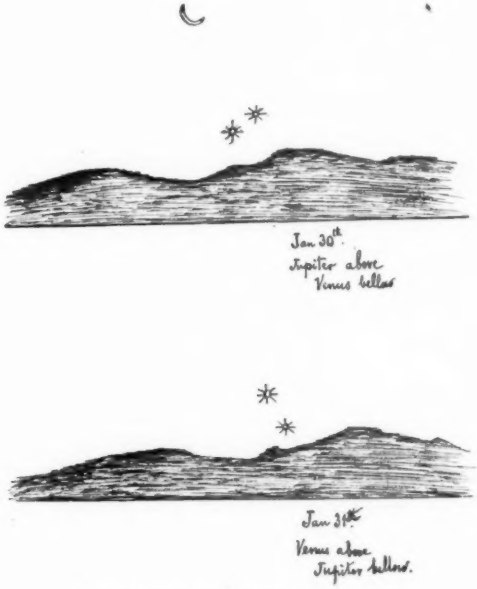
If, then, we take 20″.52 as the definitive value of the constant of aberration the solar parallax will be 8″.78, corresponding to that obtained by Gill's observations of Mars in 1877, which makes the distance of the Sun about 93,107,000 of miles.

The Last Conjunction of Venus and Jupiter.—As I had announced in my "Astronomical Year Book for 1903," on the 30th of January witnessed the conjunction of the two most beautiful planets of our system, viz.: Venus and Jupiter.

On the 24th of January I measured the apparent distance between both planets. Jupiter was 12 degrees above the horizon and Jupiter was 7 degrees above the horizon; so the distance between them was of 5 degrees. I waited until the setting of Venus and as soon as this magnificent planet reached the edge of the mountain I saw something like a spark and the planet disappeared.

The day of the conjunction had been beautiful and clear; but after midday some clouds began to gather in the western part of the sky. I was disappointed, but fortunately about five o'clock a light wind from the north sent the clouds away and we could view the interesting phenomenon.

As my drawing represents, Venus and Jupiter were near enough to be inside the field of my 108mm. telescope, making the view of them so good that it cannot be forgotten.



CONJUNCTION OF VENUS AND JUPITER.

On the 31st of January Jupiter had already passed Venus as our drawing No. 2 shows. Jupiter is now hidden by the glare of the Sun, but Venus remains a very conspicuous object as she appears in the charming role of the *evening Star.*

LUIS G. LEON.

MEXICO, February 1903.

Total Solar Eclipse Jan. 21-22, 1898, Jeur, India.—We have been favored with a copy of the report of the total eclipse of the Sun January 21-22, 1898, as observed at Jeur in western India, by Kavasji Dadabhai Naegamvala, director of the Maharaja Takhtasingji Observatory at Poona, India. This interesting report has a variety of useful matter in it that deserves a fuller notice than we can now give for want of space. We will give next time something of the photographic and spectroscopic results obtained from this report.

Full Sets of Popular Astronomy.—The large sale of POPULAR ASTRONOMY made during the last month at the reduced rates, has so lowered our supply that full sets of this publication can not longer be offered at such greatly reduced price. Persons desiring Volumes 1, 2, 3 or 4 can secure them in pamphlet form, in perfect condition, for one dollar per volume, as long as the supply lasts. We have more of these volumes than of other later ones. These volumes are especially valuable in presenting elementary work in astronomy for the aid of teachers and students who wish more knowledge of the ways of practical work and late methods in the study of astronomy.

New Plan of Time Service.—On June 14, 1902, a new system of public time signals, devised by Mr. Gerrish, was put into operation. Incandescent electric lights are made to pulsate in response to the telegraphic signals of the standard clock, reproducing visually the regular standard signals which have hitherto been sent out by telegraph. A single 32-candle-power lamp has been placed on the top of the residence of the Director and can readily be seen by the unaided eye at a distance of four miles. A group of lights in the window of the Traveller office at 76 Summer St., Boston, serves to give accurate time to the public in the vicinity of the South Terminal Station. Unfortunately, neither of these signals is visible from the water front. At a trifling expense a light could be maintained in Boston which could be seen all over the harbor, and would be of great value to shipmasters and others. The new system has many marked advantages over the time-ball. The signals are automatic, can be seen much farther, and can be operated continuously.—*Annual Report of the Director of The Astronomical Observatory, of Harvard College.*

The Sun's Stellar Magnitude and the Parallax of Binary Stars.—In the January *Monthly Notices* J. E. Gore has an instructive article on the stellar magnitude of the Sun and the parallax of binary stars. By the Sun's stellar magnitude is meant the number which represents the Sun's brightness, as seen from the Earth, on the same scale as the brightness or magnitude of the stars is determined. The Sun's magnitude is usually rated between — 25.5 and — 27.0.

Mr. Gore has developed an interesting method for the measure of the brightness of the Sun which is new to us, but not at all difficult. He computes this value from the apparent brightness of binary stars whose orbits are well determined and whose spectra resemble that of the Sun. Results from different stars agree well.

Astrographic Chart at the Royal Observatory, Greenwich.—In accordance with the the recommendation of the International Committee, a limited number of the photographs for the Astrographic Chart, taken at the Royal Observatory, Greenwich, England will be reproduced from original negatives and published, being enlarged to twice the scale.

The enlarged prints are to be made by contact on bromide card, 15 in., by 12 in., from an enlarged positive on glass.

This reproduction is to be limited to 50 sets to be distributed to a selected list of observatories and institutions including the eighteen participating observatories where there are proper provisions for the satisfactory storage of the 22,000 sheets of which the chart will consist.

The total cost of the reproduction of this fifty sets of photographic charts is estimated at about $15,000. It will probably take two men five or six years to do the photographic work. Like every other important movement in modern life, astronomy is doing some things on a scale fitted to the twentieth century idea.

New Method of Time Reckoning.—In *Nature* Feb. 5, 1903 is found the following: "The decimal division of time has been advocated for some years by writers in several French periodicals. A Geneva correspondent of the Globe states that a number of manufacturers in the Neufchatel canton have already taken to the manufacture of clocks and watches on the decimal system. Chambers of commerce and other trade organizations are also supporting the change. The Cantonal Commercial Chamber at Chaux-de-Fonds has issued a notice calling for models, drawings and designs for appliances and 'works' applicable to the decimal adjustment of clocks and watches with the least possible departing from forms now in use."

It begins to look as if one of the next steps in the use of the metric system might come in the division of time. That would certainly help in the use of the same system generally in America.

Publications of the Washburn Observatory, Vol. XI.—This is a splendid volume of 435 pages, containing the results of meridian observations for stellar parallax during the years 1893-96, by Albert S. Flint, assistant astronomer. The observations were made with the Repsold meridian circle of 12.2^{cm} aperture and consisted in determining the difference of right ascension between each star in question and two other stars, generally fainter, the one preceding it and the other following it in transit. A screen apparatus was used to reduce the apparent magnitudes of the brighter star, so as to bring them near to an equality with the comparison stars.

The comparison stars "were selected with special reference to symmetry of position, and so it happened in some cases that there were adopted stars of different magnitude from what would otherwise have been chosen; for experience has shown that symmetry of apparent magnitude between the parallax star and its comparison stars, is of greater importance than symmetry of position."

"The list of parallax stars consisted primarily of all stars which have a known proper motion of one second of arc or more in a great circle, and which were sufficiently bright for the instrument and far enough north to be observed in this latitude. Later a number of Professor Burnham's double stars having considerable proper motion were added to the list, and a few other stars. Some of them, however, were taken on too late to secure any considerable number of observations in the series and some stars of the original list proved to be too faint for observation. There remain 96 parallax stars, the observations of which were subjected to a uniform process of reduction by the method of least squares."

Mr. Flint is to be congratulated upon this large list of parallaxes of stars with such a wide range of magnitude (-1.4^m to 9.1^m), and upon the substantial agreement of his results with those of former investigators, which gives confidence in his work. About one-third of the list consists of stars whose parallax has previously been determined. The other two-thirds adds a large and valuable contribution to our knowledge of the structure of the universe.

The following table, abstracted from two different tables in the volume reviewed, gives Mr. Flint's results together with the positions, magnitudes and

proper motions of the stars. In the last three columns, π is the parallax of the star resulting from the solution of the equations of condition; r_π is the computed probable error of the parallax; π' is the parallax corrected for a systematic error, which Mr. Flint found to depend upon the difference of apparent magnitude between the star and its comparison stars and upon the season of the year. In a few cases when two pairs of comparison stars were used, or the two stars of a pair gave discordant results, both results are given in this table:

Star.	Mag.	R. A. 1895.0.	Decl. 1895.0.	Proper Motion.	π	r_π	π'
		h m s	° ′	″	″	″	″
β Cassiopeiae	2.4	0 03 34	+58 34	1.0	+0.17	±0.029	+0.10
Groombridge 34	8.1	0 12 23	+43 26	2.8	+ .44	.034	+ .31
Piazzi D, 130	5.6	0 31 57	−25 17	1.4	− .01	.050	+ .35
η Cassiopeiae	3.6	0 42 45	+57 16	1.2	− .02	.044	+ .34
Mayer 20	5.7	0 42 52	+ 4 44	1.4	+ .18	.098	+ .16
					+ .30	.079	+ .12
μ Cassiopeiae	5.2	1 01 17	+54 24	3.7	+ .12	.026	+ .07
θ Ceti	3.8	1 18 46	− 8 44	0.2	− .08	.056	+ .09
ω Andromedae	4.8	1 21 22	+44 52	0.5	+ .18	.042	+ .08
τ Ceti	3.6	1 39 11	−16 29	1.9	+ .18	.062	+ .47
α Arietis	2.0	2 01 15	+22 58	0.1	.00	.065	+ .08
δ Trianguli	5.0	2 10 38	+33 45	1.2	− .03	.055	.00
					+ .20	.067	+ .20
Piazzi ii, 123	6.5	2 30 19	+ 6 23	2.4	− .05	.043	+ .11
ι Persei	4.3	3 01 29	+49 13	1.3	.00	.033	+ .10
Lal. 6888-9, prec.	8.2	3 39 52	+41 08	1.4	− .04	.040	− .14
Lalande 7443	8.5	3 56 12	+35 01	2.2	+ .21	.055	− .02
o^2 40 Eridani	4.5	4 10 26	− 7 49	4.1	+ .34	.042	+ .21
					+ .22	.039	+ .11
α Tauri	1.0	4 29 54	+16 18	0.2	− .09	.058	+ .02
Lalande 9091	7.5	4 45 23	+10 53	...	− .09	.044	− .03
Lalande 9109	6 8	4 45 54	+13 29	...	− .11	.068	.00
W. B. iv, 1189	6.3	4 55 36	− 5 52	1.3	+ .15	.042	+ .29
α Aurigae	0.2	5 08 56	+45 53	0.4	+ .06	.035	+ .01
W. B. v, 592	8.7	5 26 09	− 3 42	2.2	+ .24	.036	+ .06
β Aurigae	2.1	5 51 50	+44 56	0.1	− .01	.031	− .00
α Canis Majoris	−1.4	6 40 31	−16 34	1.3	+ .28	.047	+ .34
97 Monocerotis	6.7	6 45 28	− 0 25	0.2	+ .17	.065	+ .25
Piazzi vi, 305	6 0	6 56 50	+29 31	0.8	− .02	.028	+ .03
α Geminorum, seq.	2.8	7 27 54	+32 07	0.2	− .14	.041	− .17
α Canis Minoris	0.5	7 33 48	+ 5 30	1.3	+ .32	.039	+ .34
Lalande 15290	8.2	7 46 51	+30 56	2.0	+ .05	.030	− .01
Lalande 15565	7.5	7 54 02	+29 32	1.2	+ .07	.026	+ .07
Lalande 16304	6.0	8 13 25	−12 17	1.0	+ .07	.030	+ .12
o Ursae Majoris	3.4	8 21 32	+61 04	0.2	+ .08	.055	+ .08
Lacaille 3386	6.9	8 28 46	−31 10	1.3	− .08	.041	− .06
A. Oe. 9342, prec.	8.5	8 45 31	+71 12	1.4	+ .13	.044	+ .09
ι Ursae Majoris	3.2	8 52 01	+48 27	0.5	+ .14	.059	+ .11
10 Ursae Majoris	4.2	8 53 50	+42 12	0.6	− .08	.041	− .07
Lalande 18115 prec.	8.0	9 07 14	+53 08	1.7	+ .12	.032	+ .10
θ Ursae Majoris	3.2	9 25 50	+52 09	1.1	+ .10	.030	+ .09
Lalande 19022	8.0	9 36 48	+43 09	0.8	− .11	.089	− .11
20 Leonis Minoris	6.0	9 54 57	+32 26	0.7	+ .05	.080	+ .05
A. Oe. 10603	6.8	10 04 57	+49 59	1.4	+ .13	.038	+ .13
Lalande 21185	7.3	10 57 36	+36 40	4.7	+ .36	.047	+ .37
Lalande 21258	8.5	11 00 16	+44 04	4.4	+ .34	.110	+ .37
Fedorenko 1831, pr.	6.5	11 08 19	+74 03	0.4	+ .21	.074	+ .17
A. Oe. 11677	9.0	11 14 34	+66 25	0.3	+ .49	.111	+ .53
Bradley 1584	6.2	11 29 23	−32 16	1.1	+ .17	.051	+ .21
Groombridge 1830	6.4	11 46 56	+38 28	7.0	+ .02	.055	− .01
Lacaille 4955	7.7	11 52 44	−27 06	1.2	+ .02	.044	+ .03
Lalande 22954 68	6.1	12 09 46	− 9 42	1.0	−0.03	±0.066	−0.08

Star.	Mag.	R A. 1895.0. h m s	Decl. 1895.0. ° ′	Proper Motion. ″	π ″	r_π ″	π' ″
43 Comae Berenices	4.4	13 06 58	+ 28 25	1.2	+ 0.09	± 0.053	+ 0.08
61 Virginis	4.8	13 12 55	− 17 44	1.5	+ .16	.033	+ .14
Lalande 25224	5.6	13 34 24	+ 11 17	...	+ .24	.098	+ .25
Lalande 25372	8.5	13 40 25	+ 15 28	2.3	+ .40	.065	+ .43
α Bootis	0.0	14 10 52	+ 19 44	2.3	+ .07	.049	+ .07
Lalande 26481	8.0	14 25 32	− 15 10	0.5	+ .28	.127	+ .30
Lalande 27026	8.2	14 45 43	− 23 52	1.0	− .04	.064	+ .03
Piazzi xiv, 212, seq	5.9	14 51 20	− 20 57	2.0	+ .14	.065	+ .04
Lalande 27298	7.7	14 52 12	+ 54 05	1.1	− .05	.036	− .04
Lalande 27744	7.0	15 08 35	− 0 57	1.3	+ .11	.031	+ .12
6 Serpentis	5.5	15 15 41	+ 1 06	0.1	+ .17	.069	+ .12
Lalande 28358	6.9	15 26 27	+ 57 48	0.3	+ .05	.045	+ .02
Lalande 28607	7.0	15 37 26	− 10 35	1.2	+ .02	.035	+ .02
γ Serpentis	4.0	15 51 36	+ 16 00	1.3	+ .11	.028	+ .05
τ Coronae Borealis	5.2	16 05 08	+ 36 44	0.4	+ .08	.047	+ .11
Lalande 30044	7.6	16 25 19	+ 4 27	1.4	− .06	.032	+ .00
η Herculis	3.7	16 39 18	+ 39 07	0.1	+ .21	.035	+ .15
Lalande 30694	7.0	16 47 41	+ 0 12	1.6	+ .03	.036	+ .01
Lalande 31055	7.5	16 59 35	− 4 53	1.5	+ .11	.030	+ .11
36 Ophiuchi, prec.	4.7	17 08 53	− 26 27	1.2	+ .36	.039	+ .36
Bradley 2179	6.8	17 09 46	− 26 24	1.2	+ .22	.039	+ .23
72 w Herculis	5.4	17 16 44	+ 32 36	1.0	+ .09	.041	+ .09
W. B, xvii, 322	8.0	17 20 32	+ 2 14	1.2	+ .18	.055	+ .17
ν^1 Draconis	4.8	17 30 06	+ 55 15	0.2	+ .01	.028	+ 01
ν^2 Draconis	4.8	17 30 12	+ 55 15	0.2		.00 .028	.00
A. Oe. 17415-16	9.1	17 37 2	+ 68 26	1.3	+ .20 + .34	.050 .051	+ .22 + .35
70 Ophiuchi	4.1	18 00 9	+ 2 31	1.1	+ .19	.029	+ .19
α Lyrae	0.2	18 33 23	+ 38 41	0.4	+ .10	.030	+ .10
Pos. Med. 2164, pr.	8.2	18 41 37	+ 59 28	2.3	+ .36	.043	+ .32
Bradley 2388	6.7	18 53 05	+ 32 46	0.2	− .04	.038	+ .01
31 *b* Aquilae	5.3	19 19 58	+ 11 43	1.0	+ .02	.030	+ .01
σ Draconis	4.7	19 32 34	+ 69 29	1.9	+ .17	.021	+ .17
α Aquilae	1.0	19 45 40	+ 8 36	0.6	+ .31	.047	+ .22
Lalande 38383	7.0	19 59 29	+ 23 04	1.0	− .05	.028	− .02
Piazzi xx, 29	6.2	20 08 44	− 27 21	1.3	− .10	.043	.00
O. Arg. S. 20452	8.2	20 17 24	− 21 41	1.2	− .16	.151	− .08
β Delphini	3.7	20 32 38	+ 14 14	0.1	− .13	.027	− .02
ϵ Cygni	2.7	20 41 58	+ 33 35	0.5	+ .13	.052	− .19
61 Cygni, prec.	5.5	21 02 11	+ 38 14	5.2	− .21	.029	+ .21
δ Equulei	4.6	21 09 22	+ 9 35	0.3	− .02	.041	+ .02
Lacaille 8777	6.7	21 13 41	− 26 47	0.4	− .04	.053	− .11
24 Aquarii	7.3	21 34 07	− 0 32	0.2	− .06	.062	+ .04
κ Pegasi	4.2	21 39 53	+ 25 10	0.0	− .10	.043	− .02
34 Pegasi	5.7	22 21 17	+ 3 51	0.3	+ .16	.060	− .06
Bradley 3077	5.5	23 08 14	+ 56 35	2.1	+ .09	.032	+ .35
W. B. xxiii, 175	8.2	23 11 39	− 14 23	1.3	+ .10	.076	+ .04
Lalande 46650	8.7	23 43 43	+ 1 51	1.4	+ .39	.092	+ .23
85 Pegasi	5.8	23 56 41	+ 26 32	1.3	− .26 − 0.01	.038 ± 0.038	+ .04 + 0.02

Program of Section A of the A. A. A. S.—The following papers, with two or three exceptions, were read in full or in abstract. It will be seen from their titles that two-thirds of them were upon astronomical topics:

1. Deflections of the Vertical in Porto Rico. O. H. Tittmann, Superintendent of the U. S. Coast and Geodetic Survey.
2. Saint Loup's Linkage. Professor L. G. Weld, University of Iowa.
3. Good Seeing. Professor S. P. Langley, Secretary of the Smithsonian Institution.

4. A Device to Prevent the Personal Equation in Transit Observations. Professor S. P. Langley.
5. The Solar Constant and its Related Problems. Professor S. P. Langley.
6. The Philosophical Foundation of Geometry. Dr. Paul Carus, Editor Open Court Publishing Co., Chicago.
7. Evidence of Structure in the Masses of the Sun. Professor F. H. Bigelow, U. S. Weather Bureau.
8. Spectrographic proof of the Rotation of the Planets Jupiter, Saturn and Venus. Percival Lowell, Director Lowell Observatory.
9. The Teaching of Geometry. Professor George Bruce Halsted, Austin, Texas.
10. The Problem of Three Bodies with Prescribed Orbits and its Generalization. Professor E. O. Lovett, Princeton University.
11. Special Periodic Solution of n Bodies. Professor E. O. Lovett.
12. Note on Secular Perturbations. Professor Asaph Hall, Professor of Mathematics, U. S. Navy (retired).
13. The Bolyai Centenary. Professor George Bruce Halsted.
14. The Approach of Comet b, 1902 to the Planet Mercury. Charles J. Ling, Manual Training School, Denver, Colorado.
15. An Untried Method of Determining the Constant of Refraction. George A. Hill, U. S. Naval Observatory.
16. A Development of the Conic Section by Kinematic Methods. John T. Quinn, Warren, Pa.
17. Time Determinations at the Washburn Observatory. Professor George C. Comstock, Washburn Observatory.
18. Determination of Time by Reversing on Each Star. Professor Charles S. Howe, Case School of Applied Sciences, Cleveland, Ohio.
19. Note on Geometrical Analysis, Professor James S. Miller, Emory, Va.
20. Concerning Bolzano's Contributions to the Assemblage Theory. Dr. C. J. Keyser, Columbia University, New York.
21. The Constants of the Equatorial. C. W. Frederick, U. S. Naval Observatory.
22. A Relation between the Mean Speed of Stellar Motion and the Velocity of Wave Propagation in a Universal Gaseous Medium, Bearing upon the Question of the Nature of Ether. Luigi d'Auria, Philadelphia, Pa.

A Texas Meteor.—Last fall the following item was printed in a Chicago paper:

"Ramon Cruise, a Mexican sheep herder, was struck on the head and killed by a fragment of a meteor while tending his flock near Ellis in Edwards county, Texas, Aug. 16. * * * The largest piece of the meteor found weighs about four pounds."

Thinking the matter to be worthy of investigation I wrote on Sept. 16, 1902 to the postmaster at Ellis and also the postmaster at Rocksprings, a neighboring town, asking several questions about the circumstances of the supposed meteoric fall. The first letter elicited a reply from A. H. Zuberbruler (Ellis, Texas) to the effect that he had never heard of the falling of any meteor in that part of the country. The Rocksprings letter brought information from two gentlemen. Mr. J. E. Burnett wrote as follows:

"So far as can be learned the facts were stated in the San Antonio Express.

There was a Mexican sheep herder out with his flock late in the evening, * * * as best the parties who examined the ground could tell. They found a large flint rock weighing five or six hundred pounds had fallen near where this Mexican was sitting, and struck a large rock near him, bursting all to pieces, and imbedding a parcel of the rock in the Mexican's skull. These are about the only facts obtainable."

On the other hand Mr. John S. Gething, of the Chas. Schreiner Co., of Rocksprings, wrote that the story was "altogether a newspaper carnard," and that there was "positlvely no foundation" for it. He wrote further "I handle Mexicans here all the time, and would have heard something about this occurrence, if it had happened! I went to the Mexican 'Capitan' here and asked him if he had heard anything in regard io this, but he said no, it never happened."

Ellis is a small postoffice in the southwestern part of Texas, in a very sparsely settled region. The county seat, Rocksprings, is less than 20 miles away. San Antonio is about 100 miles from Ellis. HERBERT A. HOWE.

UNIVERSITY PARK, Colo., Feb. 14, 1903.

Five Sundays in February.—The month of February began this year on Sunday. If it were leap year there would be five Sundays in February, the fifth coming on the extra day, the 29th. But it is not leap year. There has not been a leap year since 1896. This is owing to the rule of the Gregorian calendar, that century years shall not count as leap years, unless their numbers are exactly divisible by 400; the year 1900 was not so divisible. Hence this lapse of eight years from 1896 to 1904. Next year will be leap year; but February will then begin on Monday, and thus there will be five Mondays in February, but not five Sundays.

It is possible to have five Sundays in February; this occurred last in the year 1880, Sunday falling on February 1, 8, 15, 22 and 29. But this will not again occur till 1920, seventeen years hence, an interval of 40 years thus intervening. The writer has searched out the law which may be said to govern the recurrence of years in which February presents five Sundays, and finds it to be as follows: Februarys containing five Sundays are 28 years apart, except when a century year occurs in the interval, when they are forty years apart; if, however, the century year be divisible by 400, the interval remains at 28 years.

This rule is easily applied. Begin with the year 1880, the last instance of a year with five Sundays in February, The century year 1900 intervening, the interval through which we are now passing is one of 40 years, and the next February containing five Sundays will be in 1920. The child born February 29th, 1880, though even now a voter, will not have another birthday on Sunday until he is 40 years old. Before another 40-year interval can be reached, we have come to the year 2,000, which, because the figure is divisible by 400, is a leap year, like ordinary years that are divisible by four. The effect of this is to cause the 28-year intervals to continue for 168 years, from 1920 to 2088, when a 40-year interval is again met, carrying us to 2128.

Further investigation proves that, for all time to come, no century year, even though it be a leap year, will ever have five Sundays in February. Such Februarys occur only in certain years whose figures end as follows: '04, '32, '60, '88, '28, '56, '84, '24, '52, '80, '20, '48, '76. This series repeats itself, for all time every 400 years. In accordance with the rule laid down above, and in accordance with this series of figures, we have the following series of years containing each five Sundays in February: 1604, 1632, 1660, 1688, 1728, 1756, 1784,

1824, 1852, 1880, 1920, 1948, 1976; then follows the next series, 2004, 2032, etc., etc., ending with 2376; then a third series, 2404, 2432, etc., etc., ending with 2776; and so on, as long as the Gregorian calendar shall prevail.

REV. FREDERICK CAMPBELL.

BROOKLYN INSTITUTE OF ARTS AND SCIENCES,
Brooklyn, N. Y.

Shades and Shadows and Perspective.—A small book of 64 pages, by Randall and published by Ginn and Company, on shades and shadows and perspective, as a branch of drawing, is at hand.

We are very glad to see a work of this kind put in form for easy and effective use for student or teacher. The definitions and notation are clear and concise, the problems for practice and the general principles for perspective in elementary way are well chosen and the eleven 4 page plates at the end of the book furnish the illustration needed for guidance in practical study.

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